The Electrical World.

VOL. XXX. NEW YORK, OCTOBER 16, 1897. No. 16.

PUBLISHED EVERY SATURDAY BY

THE W. J. JOHNSTON COMPANY,

253 Broadway, New York.

Established 1874. Incorporated 1889.

Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 620 Atlantic Ave., Boston.
Western Office, 936 Monadnock Block, Chicago.
Philadelphia Office, 929 Chestnut Street.

SUBSCRIPTION IN ADVANCE, ONE YEAR, $3.00,

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253 Broadway, New York.

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ELECTRIC TRACTION FOR EXISTING STEAM RAILWAYS.

The time for the equipment of railways now operated by steam is so nearly at hand that the discussion of ways and means for the replacement of the locomotive is of peculiar interest. Indeed, there is no other subject of such commanding importance in the whole field of electrical engineering, and no opportunity in sight so ripe and promising as that furnished by the vast systems of intercommunication and traffic now worked by methods which are fast becoming obselete. In the discussion on another page of the problems presented by the Pennsylvania Railroad's suburban lines near Philadelphia it is shown that the equipment of those railways is possible and practicable, and that electrical engineers and manufacturers are ready to-day to contend successfully with the difficulties involved. There is a larger question concerned than in the details of equipment, however interesting these may be, and that is the result of such a change of motive power upon the railway company's business and upon the public.

The probable immediate effect of such a change would be a decrease of earnings, due to the large outlay necessary for the plant and equipment. The expenses of operation would show a decrease from the beginning, while the effect upon travel would necessarily take a short time to manifest itself. When the public begin to learn, however, that a suburban service exists, rapid, comfortable, convenient and not expensive, free from the nuisances of dirt and noise and smoke and cinders, which are such marked features of the steam-train service, it will at once begin to respond and show its appreciation. This fact seems utterly incontestable. Over and over again it has been proven that a demand may be created by the introduction of a means of supply. To those who can remember the day of messengers before the telephone wrought its revolution in the business facilities of our cities it is patent enough. But no one could have foretold the effect of the telephone, or imagined how the use of it would extend, until, in a short time, it should come to be a factor of the greatest importance in everyday affairs. It is precisely so with the foreshadowed system of high-speed electric traction. It growth cannot be estimated, and its effect cannot be predicted in full. It suffices to say that its results would be an increase in the bounds of suburban districts, a greater efflux of urban population, a larger and larger use of the railways, and, in the end, a constantly growing dividend.

Already the steam roads have felt the competition of the suburban trolley lines in decreased business. The slower and less comfortable electric cars do not burden their passengers with a schedule. They take the passenger where he wishes to go and set him down at his own door post. It is the possibility of this sort of service, the multiplications of stations, and the working of lines stopping from house to house on demand, as feeders, that makes the introduction of electric service imperative with those railways having an extended system.

While the value of electric traction for this sort of service is great and apparent, it does not follow that the same is true for long-distance high-speed service On the contrary, it seems that the steam locomotive has certain advantages for this sort of work. It has not been determined at what point the electric system be-

comes unable to compete with steam, but it is evident that the cost of transmission over very long distances would be prohibitively high, while the sub-division of the generating plant is expensive and detrimental. Nevertheless, the evidence contained in the article referred to shows that a high-speed electric local train system between New York and Philadelphia could very likely be profitably inaugurated. That the next few years will see some such systems installed is an unquestioned truth. The future of electricity with this field before it is full of abundant promise.

THE PROFIT IN GOOD ENGINEERING.

The description of the Ogden power plant in this number of The Electrical World may serve to set at rest some doubts on the part of owners of water powers as to the advisability of their development for power purposes. There always arises the question of the comparative cost of the electrically distributed water power and the locally generated steam power. Calculated theoretically, the outlook often appears unfavorable for the water power, but the fact must be remembered that steam power in small units is almost invariably developed very wastefully, while the scientifically laid out water-power plant and electrical distribution system is remarkably economical in power. The Ogden plant proposes to supply power over a large area, reaching points, in certain instances, 60 miles or more from the power house. Within this area the cost of slack coal is not more than $2.25 per short ton. When the expense of the heavy dam, the 6 miles of conduit, and the long transmission line is taken into account, it would seem as though steam power would have the advantage of comparatively lower cost. But this is not the case, owing to the fact that the majority of steam plants are poorly designed, cheaply built, and operated in a careless way that makes the cost per horse-power per annum sufficient to give the electric power a generous margin and a comfortable profit.

INDICATING, INTEGRATING AND RECORDING INSTRUMENTS.

All instruments used for electrical measuring purposes may be divided into these three general classes. The construction of indicating instruments has reached a high state of perfection for direct currents, and is rapidly approaching the same condition for alternating-current work. The integrating instruments, commonly but erroneously called recording instruments, are also represented by many very satisfactory types. Neither of these, however, gives the complete and detailed information often desired in electrical-generating plants. The first class gives nothing but an immediate visual indication of the quantities measured, and that only when under observation. The second class gives the sum of the total output of current or power, as the case may be, during any interval between observations. A good recording instrument would give a complete record of all changes in the quantity measured at any time. Such a record furnishes the only reliable data on which to base rules for the starting and stopping of boilers, engines and dynamos; for the determination of the value of such auxiliary apparatus as, for example, storage batteries, and for the decision of all questions dependent on that important ratio, the load factor. The determination of the losses in feeders and mains can only be made with the aid of such a record, as such losses vary with the square of the output, and hence their mean cannot be found from the average output.

Recording instruments for most purposes are designed to trace a record either with a pencil or pen on any suitable surface. The friction involved in this operation is a serious difficulty when the recording point is designed to be driven by delicate electrical-measuring devices. Many suggestions have been offered for frictionless methods of recording the measurements, for example, the deflection of light rays impinging upon sensitized paper, or the use of electrostatic discharges, but such methods seem better adapted to laboratory than to commercial uses. Where the outputs to be measured are very large, as is the case with many modern lighting and street-railway plants, the measuring devices might be made sufficiently massive and powerful to reduce the friction error to a negligible quantity. The accurate recording of such large quantities would be so valuable that the enegy required to operate instruments of such a size would be negligible.

THE STEAM TURBINE.

In another part of this issue will be found an abstract of a paper on some phenomena of steam turbines. Additions to the present knowledge of high-speed rotation and the kinetics of vapors are highly valuable at the present time. The comparative simplicity of the impulse wheel over the reciprocating engine, and its enormously increased output per unit of weight, make it well worth while to overcome the serious difficulties involved in its high speed. Previous to the general use of steam power for electrical generation the steam turbine would have been of little use, owing to the difficulty of efficiently reducing its speed to that of the devices to be driven. The electric generator is by nature a high-speed machine, and years of experiment and development have been necessary to bring it down to a speed sufficiently low for direct connection to the conventional steam engine. If, however, the steam turbine is developed and proven to be a successful prime mover, there will be no difficulty in building electric generators to which it can be coupled. As pointed out by Mr. McElroy, the peripheral speed of a high-pressure steam turbine is sufficient to strain the best of steel to its elastic limit. However, it is obvious that by the compounding of steam turbines the peripheral speed can be reduced with ease. The steam turbine is by nature so simple and so small that its multiple compounding will be much easier than that of the reciprocating engine.

THE STREET RAILWAY CONVENTION.

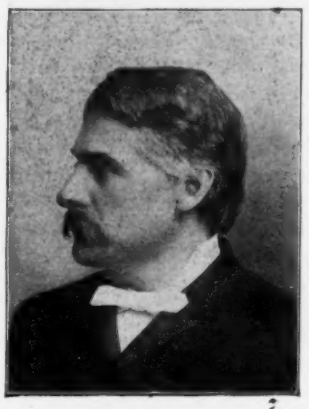
The American Street Railway Association will hold its sixteenth annual meeting at Niagara Falls next week, and it is confidently expected that an unusually large attendance will make this one of the most interesting conventions of the body. In looking over the programme, which is printed on another page of this issue, the striking fact is manifest that all of the papers to be read deal with electricity in one form or another, except one on the "Discipline of Employees." Street railway operation in this country has latterly come to mean electric railway operation. To those who can remember the first meetings of the American Street Railway Association, when the topics for discussion were such as the use of feed choppers, proper methods of shoeing horses and the ventilation of stables, the change is distinctly noticeable. Street railway men have had to learn electrical engineering, and they have mastered their lesson most thoroughly.

Some of the papers to be read promise to be of the deepest interest, and a number of the titles are very suggestive. Probably the most important subject that will be discussed is the use of multiphase current for ordinary street railways, a paper on that subject from Mr. Maurice Hoopes being on the programme. The trolley road of to-day has reached a point in its evolution when further progress along the lines that have marked its growth seems to be confined within narrow limits. It is about time for a radical innovation, and doubtless this will be through the use of polyphase current and motors, thus dispensing with the serious problem of the commutator.

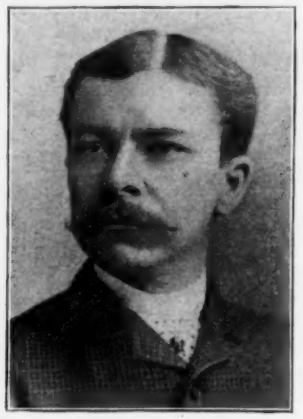
The Sprague Electric Company.

One of the most important consolidations of electrical enterprises that have taken place in some time has just been consummated in New York, by which the Sprague Electric Elevator Company and the Interior Conduit & Insulation Company have joined hands to form a new and strong company to do a general electrical manufacturing business.

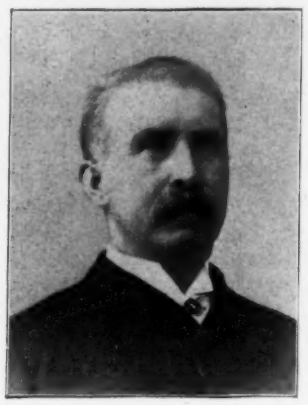
The new corporation, which will be known as the Sprague Electric Company, was incorporated at Trenton, N. J., on October 11, with a capital stock of $5,000,000. Half of this amount is in cumulative 6 per cent. preferred stock, while the other half is common stock.



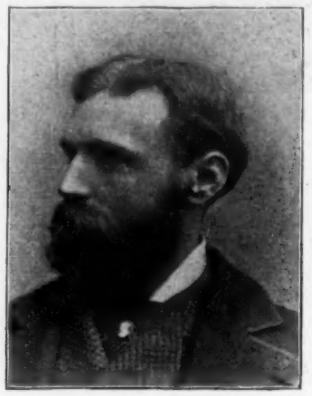
A. B. CHANDLER.



E. H. JOHNSON.



J. W. MACKAY.



E. C. PLATT.

The manufactures of the consolidated company will include those formerly put upon the market by the Sprague and Interior Conduit Companies, as well as several new and important independent inventions. Among these latter the most noteworthy are Sprague's new multiple unit electric-railway system, Lundell's new dynamos and rotary transformers and the Johnson-Lundell surface contact electric-railway system. Lundell's motors and dynamos will be manufactured in all sizes, and a large number of other inventions of this ingenious young Swedish engineer will also be exploited by the company.

The new capital has all been underwritten, and the company will enter the field at once free of all obligations and liabilities of every kind. The present factory of the Interior Conduit Company in New York will ultimately be sold, and the manufacturing

F. J. SPRAGUE.

ROBERT LUNDELL.

will all be consolidated at the works of the Sprague Company at Watsessing, N. J. The offices will be in the Postal Telegraph Building 253 Broadway, New York.

With its ample factory facilities, the Sprague Electric Company expects to be able to immediately undertake and execute all orders. The contract to equip the South Side Elevated Railroad of Chicago with the new Sprague electric railway system will be taken over by the new company. Detailed descriptions and illustrations of this system were published in THE ELECTRICAL WORLD of August 7.

The board of directors of the new company is a particularly strong one, as follows: Albert B. Chandler, Edward H. Johnson, Frank J. Sprague, Edward C. Platt, John E. Searles, John Markle, Carl Schurz, Allan C. Bakewell, W. Murray Crane, William H. Baker and John O. Stevens. The officers are: A. B. Chandler, president and managing director; E. H. Johnson, first vice-president and general manager; F. J. Sprague, second vice-president and technical director; E. C. Platt, secretary and treasurer. Although the name of Mr. J. W. Mackay does not appear in the list of directors, or as an officer, he is largely interested in the new enterprise.

History repeats itself in the electrical as well as in other lines. Mr. Johnson and Mr. Sprague, who worked together in the Sprague Electric Railway & Motor Company in the early days of electric railroading, find themselves once more associated in the recently organized Sprague Electric Company. Mr. Johnson has for the last five years sought to expand the field of his operations, and is receiving many hearty congratulations on the successful outcome of his efforts. The gentlemen prominently identified with the new company are so well known in electrical circles as to require no introduction to readers of THE ELECTRICAL WORLD. Mr. Chandler has been prominent for many years as president of the Postal Telegraph Company, while Mr. Platt is the competent treasurer of the same enterprising and liberally managed corporation.

The Trans-Mississippi Exposition.

The Trans-Mississippi and International Exposition, which will be held in Omaha, Neb., from June to November, 1898, will contain an electrical exhibit with many interesting features. Mr. Luther Stieringer has been engaged as consulting electrical engineer for the exposition. The illumination features will reveal some handsame effect arranged by Mr. Stieringer, among which will be an "electrical garden," showing the various hues and tints of the flowers by means of colored screens and powerful searchlights. Electricity in agricultural work will also form one of the special features, and recent applications of electricity in mining, electrometallurgical processes, long-distance telephony, electric cooking, etc., will be prominently exemplified. Applications for space have been made by many well-known electrical concerns. It is the desire of the officials of the exposition to bring together on this occasion an electrical exhibit that will be the finest demonstration of the kind ever assembled.

A Cable to Iceland.

In connection with the proposed submarine telegraph cable between the North of Scotland and Iceland, it is stated that the Icelandic Parliament has granted the Great Northern Telegraph Company, of Copenhagen, a subsidy of 35,000 kroners for 20 years. The distance from the nearest point of Scotland to the Faröe Islands is about 250 miles, the greatest depth being 254 fathoms, while the bottom is composed of débris of shells and mud. The distance from the Faröe Islands to Iceland is about 350 miles, the depth averaging a little under 300 fathoms, the bottom being there also composed of sand, shells and mud.

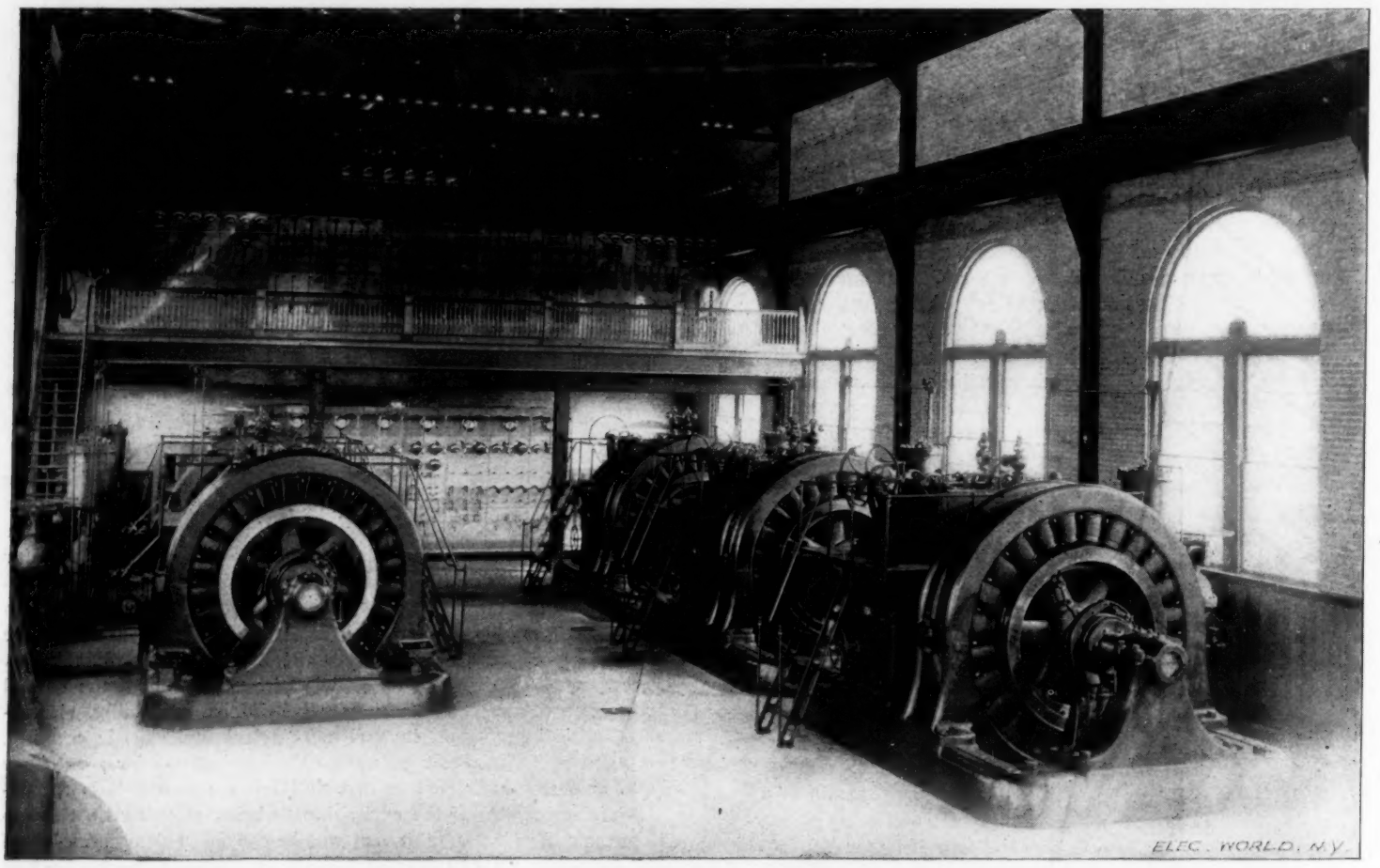
The Power Transmission Plant at Ogden.

OGDEN, Utah, is situated in the basin of the Great Salt Lake, at an elevation of 4300 feet above the sea level. It is about 13 miles from that body of water and 35 miles north of Salt Lake City. East of the city are the Wahsatch mountains, towering 5000 feet above the basin. Intersecting these mountains is the canyon of the Ogden River, a narrow winding gorge walled in by precipitous mountains, and presenting a succession of scenes of beauty unsurpassed in any other portion of the Rockies. The canyon is only a few hundred feet in width at the bottom all the way between its mouth and a point 6 miles above, where it broadens out into a noble valley, some 8 miles long by 4 miles wide. The Ogden River, flowing through this canyon, drains an area of about 360 square miles. The flow of water varies between a minimum of 80 cubic feet and a maximum of 4800 cubic feet per second.

The Pioneer Electric Power Company has undertaken the utilization of the waters of this river for the development of power, and for irrigation. A masonry dam at the upper end of the canyon will be built, which will back the water up in a reservoir, covering about 2000 acres, and with a capacity of approximately 15,000,000,000 gallons. The dam is to be built of concrete masonry founded on bed rock. The length of its crest will be 400 feet. It will rise 60 feet above the present river bed, and the foundation is to be sunk 40 feet lower, making a total height of over 100 feet. The sides and bottom of the canyon at the location of the dam consist of limestone rock, but the bottom is covered to a depth of about 40 feet with coarse gravel. The spillway for carrying off flood waters will be on the north side of the canon. At present a small timber dam is in service.

A 9-foot tunnel has been driven through the solid rock around the south end of the dam. At the upper end it is provided with six 60-inch ports and sluice-gates for controlling the water. The water flows from this tunnel through a riveted steel pipe 8 feet 6 inches in diameter and 100 feet long to the main gate house. This building contains two 72-inch valves, one of which delivers into the main conduit, and the other discharges surplus water. The main conduit is a closed pipe with an internal diameter of 6 feet. Its length over all is 31,600 feet, of which 27,000 is of wooden stave construction, the last 4600 feet being riveted steel pipe. It is laid in a trench and covered with 3 feet of earth. The flow will be such as to cause a fall of .2 per cent. in the hydraulic grade line, the wooden pipe being kept just below a gradient of this slope. The last 2 miles of the trench are excavated almost entirely in rock. There are eight tunnels in the rock, the longest of which is 667 feet. There are also eight steel bridges and a timber trestle. The maximum pressure on the wooden pipe will be that due to a head of 117 feet, or about 50 pounds per square inch. At the lower end of the conduit, where the pressures exceed this flow, a riveted steel pipe is used. The slope of the steel pipe is quite steep, which runs the pressure up to 200 pounds per square inch. The steel pipe is carefully covered inside and outside with a glossy coating of asphalt, the idea being to reduce the resistance to flow and prevent rusting. At its lower end the steel pipe divides into two branches, 4½ feet in diameter aand about 100 feet long. These branches run respectively along the two sides of the power house, and from them are tapped the branches for the nozzles.

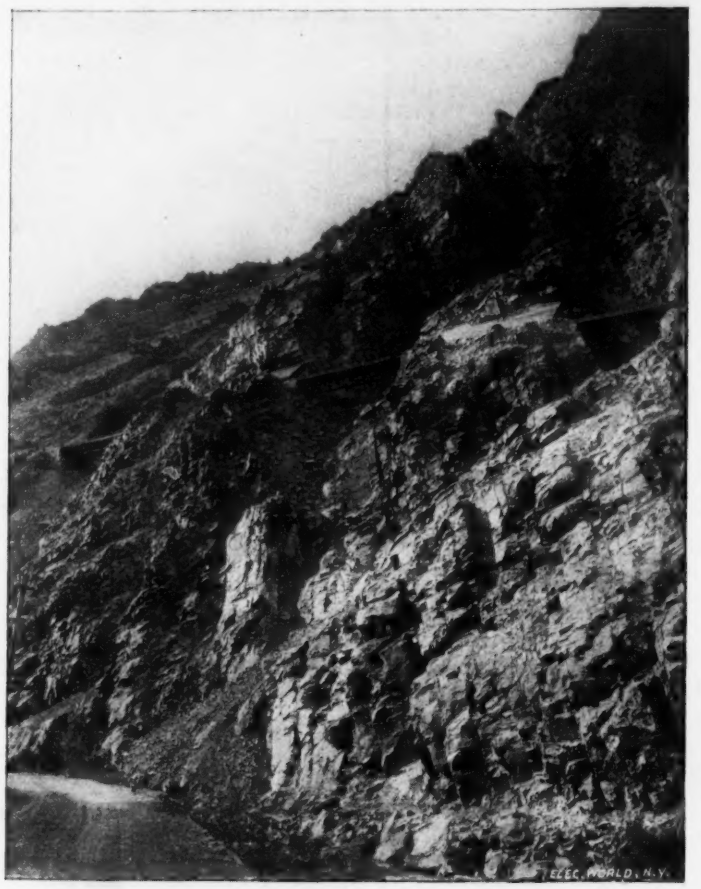
The power house is a structure 135 feet in length by 50 feet in width, built of pressed brick, with concrete and rubble footings and cut stone trimmings. The roof is built on steel trusses, which are supported on steel columns embedded in the walls. The covering consists of fir planking, over which is laid steel roofing. A hand power traveling crane of 15 tons' capacity is mounted to traverse the whole building.



General View of Interior of Power House.

The prime movers used are water wheels of the impulse type, 58 inches in diameter, with a capacity of 1200 horse-power each, at 300 revolutions per minute. The complete plant will comprise ten such wheels, but only five are at present installed, although the power house is built in such a way that the whole number can

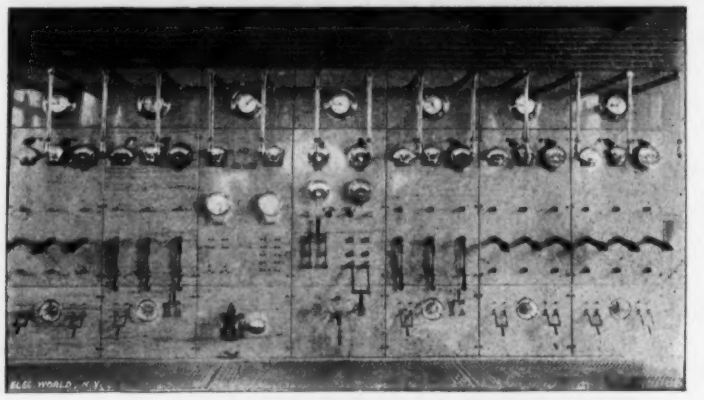
be erected at any time. The pipe line, with a flow of 9 feet per second, can deliver 250 cubic feet of water per second at an effective head of 440 feet. This gives 12,500 available horse-power at the nozzles. The wheels are of the Knight pattern, differing from the Pelton wheel in that they have full instead of divided buckets, and are also provided with heavy fly wheels to assist the regulation. The nozzles are provided with six ports, each of a size to supply 209 horse-power. These ports are rectangular, measuring 1¾×3½ inches, and are mounted in the nozzle so as to deliver the water tangentially against the wheel buckets. These ports are controlled



Trestles and Tunnels on the Pipe Line.

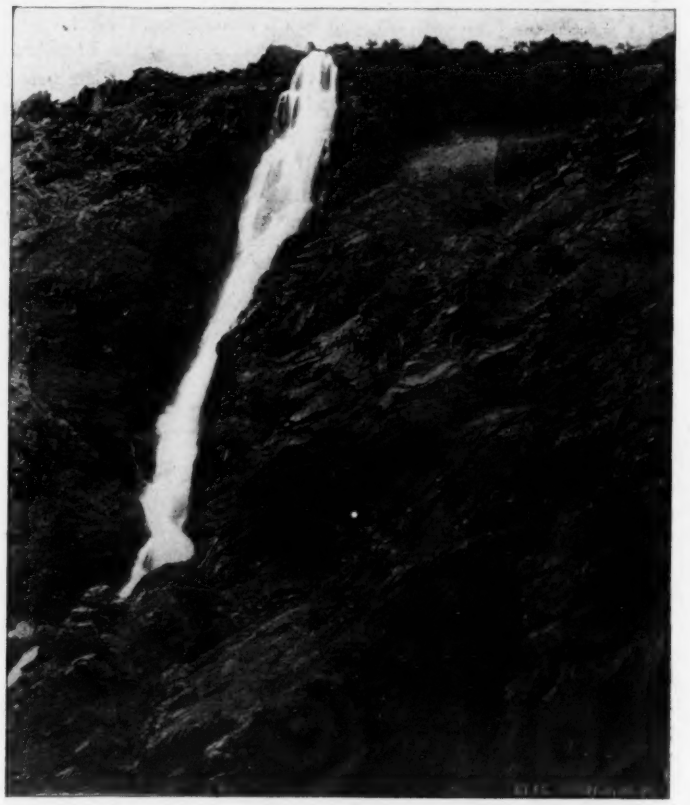
hydraulically by the switchboard attendant. The speed is governed by the Knight combined mechanical and electrical governor. This governor controls the speed mechanically under gradual changes of load, but with more abrupt changes an electrical device takes hold and helps the mechanical, moving the gates twice as fast. In case of very large changes of power, the electrical device throws the mechanical part out and moves the gates ten times as fast as the mechanical, thus providing very quick governing. It is obvious that with a pipe line of this type any sudden change of nozzle opening will vary the effective pressure greatly, owing to the inertia of the very long column of water. This feature tends to make the governing more difficult, as the pressure rises when the load falls, and vice versa. At a point near the junction of the wood and iron pipes, the conduit passes through a tunnel, and a relief shaft was bored from the tunnel vertically to the surface. This relief shaft allows the water to rise and overflow in case the pipe is suddenly shut off from below. In addition to this a standpipe was built still nearer the power house, 49 inches internal diameter, and following up a convenient grade until above the reservoir level. The receivers are also fitted with safety valves.

The water wheels have centres of cast steel, and forty-five bronze buckets cast in one solid ring are secured with bolts to these centres. Each water wheel is provided with two fly wheels, 70 inches in diameter, weighing 2 tons each, and placed inside a housing on each side of the water wheel. The total weight of the revolving parts is 15 tons, the inertia of which greatly helps in maintaining a uniform speed. Between the two lines of machines and down through the centre of the building underneath the concrete floor, is a tail race, which receives the water discharged from the wheels and carries it back to the river. The water is measured continuously by two Venturi meters, one in the branch pipe supplying each reservoir. These will record the flow accurately from a maximum of 15 cubic feet to a maximum of 130 cubic feet per second. The wheels are direct-connected to General Electric three-phase alternating-current dynamos. These dynamos give an output of 750 kilowatts each, at 2300 volts, with a frequency of 60 cycles per



Low-Tension Switchboard.

second, when running at 300 revolutions. The generators are of the inwardly projecting pole type, with revolving armatures. The machines are connected to the switchboard through subways which carry lead-covered three-wire concentric 250,000 circular-mil cables. There are two exciters direct connected to 125-hp water wheels. Each exciter when running at 550 revolutions can give an output of 100 kilowatts at 500 volts, which is ample for exciting the

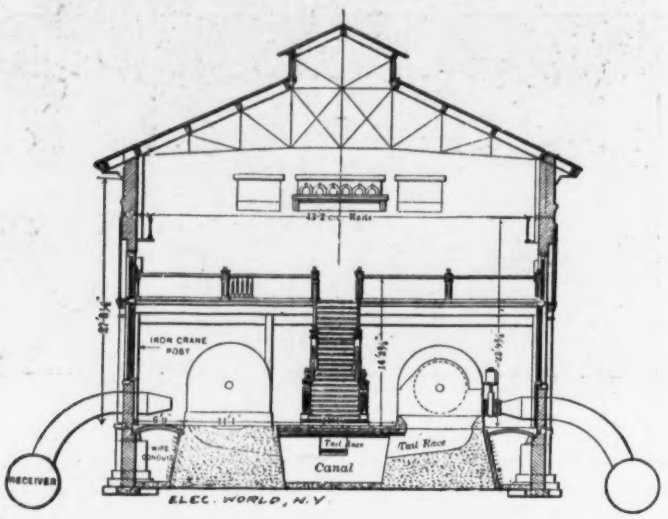


A Relief Overflow on the Pipe Line.

ten alternators. The exciter water wheels are cross connected to each receiver, so that either exciter can be operated from either receiver. The arrangement of the power units is symmetrical on either side of the tail race which runs down the centre line of the building. Each side of this tail race is a continuous foundation of concrete on which the row of machines is placed.

Across one end of the power house is placed the switchboard, consisting of seven marble panels. Five of these are for the alternators, one for the exciters and one for instruments. Each generator panel is fitted with one alternating voltmeter, one ammeter and

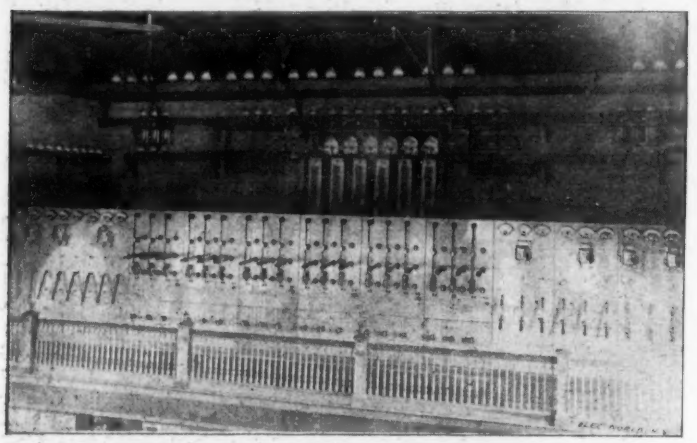
one wattmeter, and appropriate switches. At the top of the panel may be seen two levers, one of which controls the main gate, and the other the nozzle ports. A dial with two handles indicates the position of the main gate and the number of ports open. The instrument panel is fitted with pilot lamps, wattmeters carrying the whole load, Bristol recording voltmeters and a Bristol recording water-pressure gauge. There is also one synchronizer and one



Cross-Section of Power House.

ground detector. The panels are 90 inches high by 36 inches wide, and are built of blue Vermont marble with nickel fittings. There are two sets of three-phase bus-bars extending the whole length of the switchboard. A small synchronous motor is provided, coupled to a tachometer, which serves as a speed-measuring device.

In a gallery above the generator switchboard is the distributing switchboard. This is divided into two sections, one for the primary and the other for the secondary leads. Each section has six panels.



High-Tension Switchboard.

The switchboard is 39 feet long, and is built of blue Vermont marble. Back of this switchboard, and on a raised platform, are placed nine 250-kw step-up transformers. These transformers raise the voltage to 16,000 volts, at which pressure it is transmitted over the long-distance lines. The transformers are single-phase, and are connected up in sets of three, both primary and secondary circuits being in delta connection. The transformers are ventilated by air blasts supplied from two blowers, each of which is direct-connected to a 2½-hp 500-volt direct-current motor.

The transmission line consists of two circuits of three wires each, No. 1 B. & S. gauge. The wires are strung in the ordinary triangular connection on cedar poles. The lines are spiraled every half mile. In Salt Lake City, 38 miles distant from the power house, the voltage is stepped down again to 2300 volts by a transformer system similar in every way to that at the power house end. With a loss of 10 per cent in the lines, 3000 horse-power can be transmitted over the wires at present in place. The intention is to double the equipment of step-up and step-down transformers with the high tension sides in series, if no trouble is found with 27,000 volts. In this way the capacity of the line will be quadrupled.

Mr. C. K. Bannister, the secretary and chief engineer of the plant, has provided water meters and electrical-measuring instruments, so that it will be possible to obtain continuous records of the water used, the energy delivered from the dynamos and the energy received at the sub-station. It will also be possible to take the records of the real and apparent power in any circuit.

The whole plant is laid out with the intention of supplying energy for light and power and railway purposes both in Ogden and in Salt Lake City, and also supplying power for mining purposes at points from 10 to 30 miles beyond Salt Lake City.

Electric Meters.

To the Editor of The Electrical World:

Sir—I beg to call your attention to what is doubtless an oversight upon your part in an editorial on the first page of your issue of September 25, dealing with electric meters.

This editorial refers to a test made by G. W. Donald Ricks, and treats especially of errors due to temperature coefficient of the armature circuit.

I would call your attention strongly to the fact that, while you refer to the text of the paper, which deals in this connection very particularly with the T. R. W. meter, you fail to refer to the communication on the same subject over the signature of Professor Ayrton, which appears on page 302 of your issue of September 11.

I beg to protest most strongly against this, knowing full well that the report as shown by Mr. Ricks in his paper does not represent the behavior of a T. R. W. meter as it is manufactured and sold commercially, nor does it even approximate the behavior of such meters.

I feel that in justice to this instrument some further statements should appear in your editorial column, calling special attention to the correction which Professor Ayrton himself has hastened to make, as above referred to, through your columns.

Boston, Mass. Caryl D. Haskins.

[The tests referred to by Mr. Haskins of course represented only the performance of the individual meter tested. If it is not to be assumed that Mr. Ricks' work was inaccurate, it showed that this particular instrument had errors due to the temperature coefficient of its armature circuit, and that if the meter was not a representative of its type, the type itself was variable, since this was a commercial instrument, and since no alteration of its temperature coefficient would likely be produced by accident or use. It was furthest from our intention to be unfair to the Thomson meter or to any other make of these instruments. It was solely desired to call attention to the need for a satisfactory and accurate low-priced instrument.—Eds.]

Electric Power in the Navy.

Secretary Long, of the United States Navy, according to a Washington dispatch, has decided to introduce electric power for the operation of the turrets on the battleships Alabama, Illinois and Wisconsin. The bid of the General Electric Company to do the work for $10,000 for each ship has been accepted. It is stated that the General Electric Company's proposal created a great deal of surprise, as one of the bids was for $175,000 for each ship, while the others are not much lower. Estimates made at the Navy Department showed that the work of installation would cost at least $125,000. The General Electric Company's low bid is puzzling to all those concerned, but no explanations are given.

Electric Time Distribution in 1857.

It may not be generally known that in the city of Brussels, in Belgium, a system of electrically-operated clocks was installed in April, 1857, at which time 100 clocks were installed, using the Nolet system; with some modifications they have been in operation ever since then.

Electric Traction for the Pennsylvania Railroad Company's Suburban Service Near Philadelphia.

A HYPOTHETICAL CASE.

BY CHARLES T. CHILD.

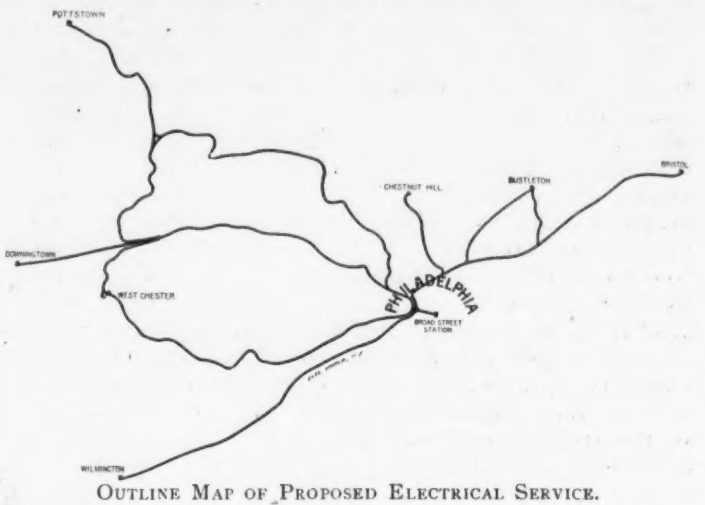
THIS article proposes to deal, in a general way, with the problem of adopting electric means for the operation of one of the most complete suburban systems of transit in existence, that of the Pennsylvania Railroad centering in the Broad Street station in Philadelphia. Within the limits of space necessarily imposed it is manifestly impossible to go into much of the interesting detail of such an extended subject. It can here be discussed only from the engineering side, leaving the fuller discussion of questions of financial feasibility and the effect of the change of motive power upon the character and volume of travel for a future article.

DESCRIPTION OF THE SYSTEM.

The passenger trains entering and leaving the Broad Street Station may be divided into three classes: Expresses, which run long distances at high speeds, making but few stops; local expresses, which run at intermediate speeds, stopping only at the more prominent stations; and local trains, making comparatively short runs and stopping at all stations. The present discussion will confine itself to the case of the local trains, the limit of distance operated being about 32 miles.

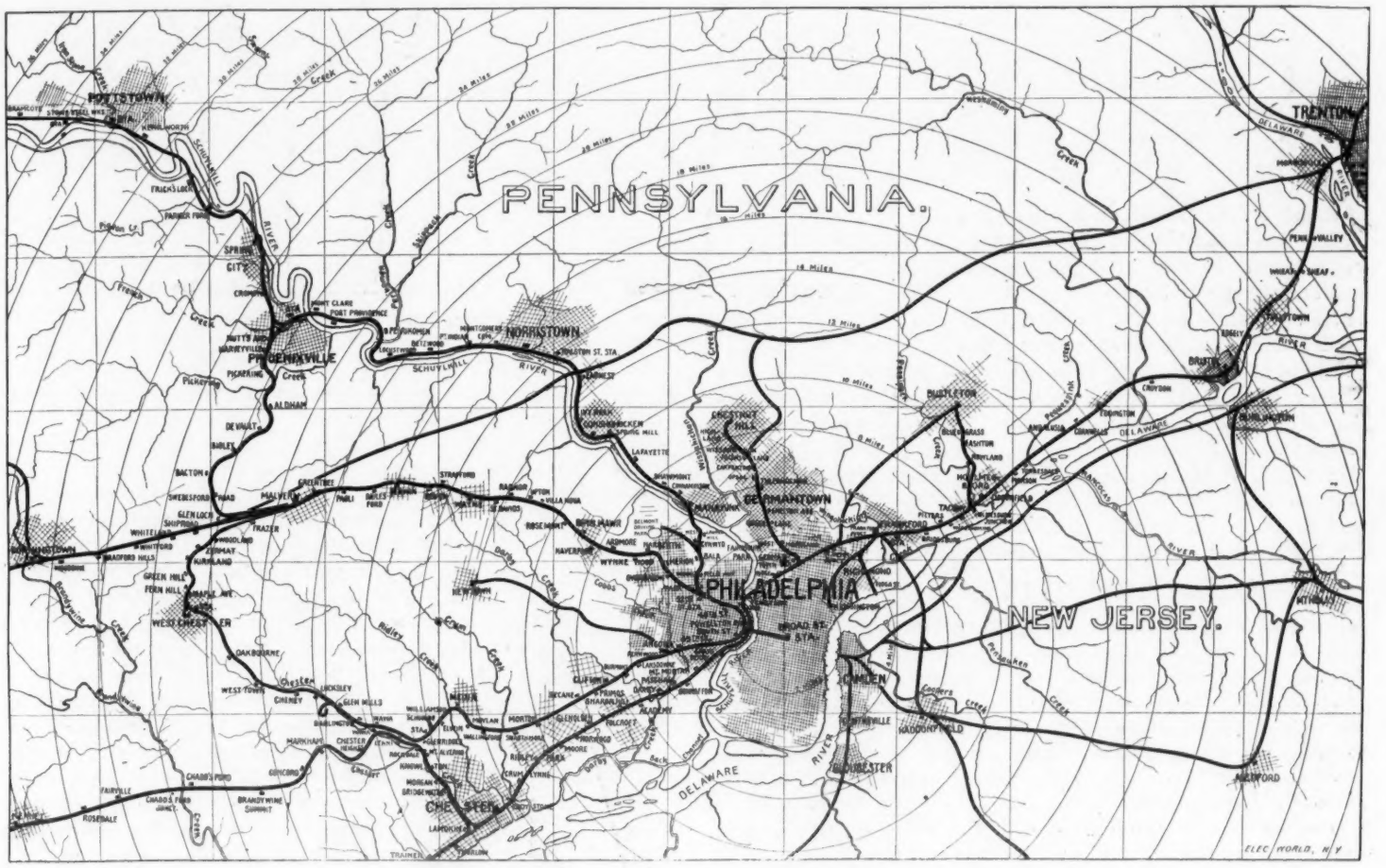
Referring to the map it will be seen that the system consists of five branches or divisions, converging to a point on the west side of the Schuylkill River, from which they run on an elevated structure to Broad Street, a distance of about 1.3 miles. Taking these in order we have:

1. The New York Division, running northeastwardly to Bristol and Trenton. The suburban service on this division is to Bristol, a distance of 23.4 miles. Two important branches to Chestnut Hill and Bustleton are heavily traveled.



OUTLINE MAP OF PROPOSED ELECTRICAL SERVICE.

2. The Schuylkill Valley Division, running in a northwesterly direction through the towns of Manayunk, Conshohocken and Norristown to Phœnixville, which may be regarded as the westerly limit of the local service in this division.



MAP OF SUBURBS OF PHILADELPHIA, SHOWING PENNSYLVANIA RAILROAD LINES.

3. The main line, running westward through Bryn Mawr, Paoli and Frazer to Downingtown, a distance of 32.4 miles. Branches at Frazer run northward to Phœnixville and southward to West Chester and this point, 30.6 miles from Philadelphia, may be considered the terminus of local trains on this branch.

4. The Central Division, running in a generally westward direction through Clifton, Swarthmore and Media to West Chester, a distance of 25.7 miles.

5. The Maryland Division of the P., W. & B. R. R., running

southwestwardly through Chester to Wilmington, Del., a distance of 26.8 miles.

The whole system comprises 160.4 miles of double track, with 159 stations. The table below gives the lengths of the various sections and the average distances between stations on each:

	Stations.	L'gths. Miles.	Average dist. bet. stations. Miles.
Maryland Division to Wilmington	29	26.8	0.956
Central Division	26	27.4	1.096
Main Line	32	32.4	1.045
West Chester Branch	6	6.7	1.340
Phœnixville to Frazer	10	11.2	1.244
Schuylkill Valley to Phœnixville	28	28.0	1.037
Chestnut Hill Branch	11	6.6	0.660
New York Division to Bristol	21	22.4	1.120
Bustleton Branch	5	3.1	0.775

With the present steam service there are operated on this system a total of 398 local trains a day, in all directions. These trains are made up, in the majority of cases, of a locomotive and tender, one combination baggage and smoking car, and three passenger cars, the whole having a seating capacity of 210 passengers. At the hours of maximum travel morning and evening, an additional car is put on some of the trains, giving them seating capacity for 270 passengers each.

The minimum headways, under present conditions, are between the hours of 4:30 and 6:30 P. M., and range from thirty minutes on the Schuylkill Valley Division to twelve minutes on the main line.

CONDITIONS DETERMINING THE DESIGN OF AN ELECTRICAL EQUIPMENT.

It is proper here to briefly indicate the objects to be attained by the equipment of these railways with electricity. First and foremost comes the possibility of higher average speed, reducing the time of transit to a given point, and thus popularizing the service. Second, and scarcely less important, is the ability to run a larger number of lighter trains at more frequent intervals, practically eliminating the schedule during the crowded hours of the morning and evening. It is hardly necessary to speak of the further advantages of electrical traction for this service, the increased cleanliness and quiet of the trains, the flexibility of the system, or its convenience and simplicity of operation.

For higher speeds the needed requisites are comparatively light trains and large power available for acceleration. Running at frequent headways the trains could be reduced to three cars, one of them being equipped with motors, having a total seating capacity for 150 passengers. Such trains complete with motors and a load of passengers would weigh 72 tons, the cars being of about the type now used on the Manhattan Elevated Railway in New York City. The calculations and figures given hereafter are based upon this train weight and a running speed of 40 miles an hour.

The electrical equipment of such a system should be undertaken only after due consideration is given to the present status of electric traction methods and the future promise of those now under exploitation. It is manifest that the first and most important requirement is absolute certainty of operation. The system must be so designed that no ordinary accident can interfere with its continuous and successful working. A reserve of power sufficient to clear the tracks of electric trains in case of a disaster at the power house is absolutely essential. Similarly a provision for an unexpected increase in the service should be made at the beginning, and every precaution against interference with steam trains on the same tracks should be taken. All of these considerations point to the selection of a system departing as little as possible from that whose excellence has been so abundantly proven in connection with street railways, but in which due provision must be made for extension of the electric service to the express trains, and for any changes in operative methods that may seem to be foreshadowed by present electrical knowledge.

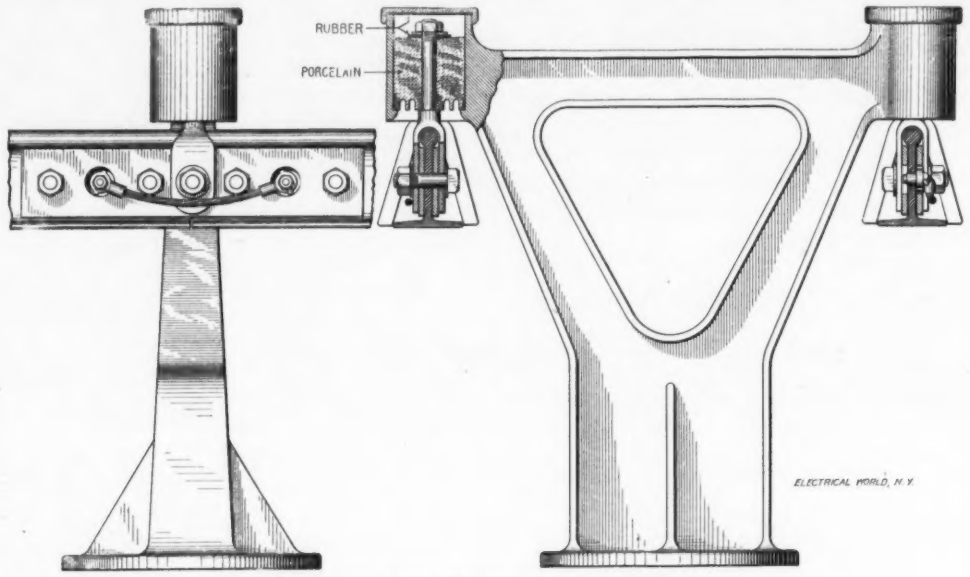
Of this it may be said that the use of polyphase motors is the only radical innovation that seems to be in prospect and that this is a long way in the future.

Taking these various matters into consideration, the systems of generation, conduction and transformation described below may be recommended as safe, practical and satisfactory, capable of almost indefinite extension, and, with slight modification, adaptable to the uses of polyphase motors should these ever be employed. It may be said here, however, that the advantages of commutatorless motors are small compared with the flexibility of the proposed direct-current and storage system outlined below.

THE ELECTRICAL SYSTEM.

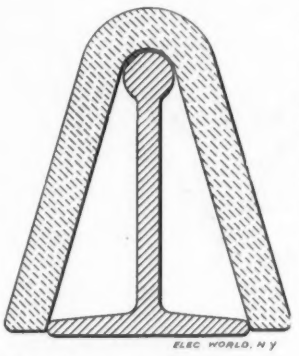
In order to attain the maximum of economy in the generation and distribution of the power it is necessary to work boilers, engines, dynamos and line under steady load and at their maxima of efficiency. It is also necessary to consolidate the power-generating plant in a single station so that the wages account may be reduced to a minimum, and also in order to reduce first cost and operation expense by increasing the size of the steam and electrical generating units.

An inspection of the map shows that at the point of convergence



A Suggestion for Insulators and Supports.

of the various lines in West Philadelphia—a point conveniently near the Schuylkill River, so that ample water for condensation may be had—is the place for the station. The general plan recommended is to here generate three-phase current at 5000 volts, distribute this along the lines to sub-stations situated at convenient intervals, reduce the pressure by static transformers and by means of rotary converters feed it into the track-conducting system as direct current at about 750 volts. At each rotary converter station there should be provided a storage battery and a booster driven by the rotary, the field of this being compounded so that it would charge the battery when demand for current from the trains became small, and help the battery to a discharge at constant potential when the load increased. The rotary converter would be, of course, connected with the track system, so that it would aid the battery in supplying current to the trains. The sketch shows the arrangement of the various parts of the sub-station and their connections.



Cross Section of Conductor Rail and Tile Covering.

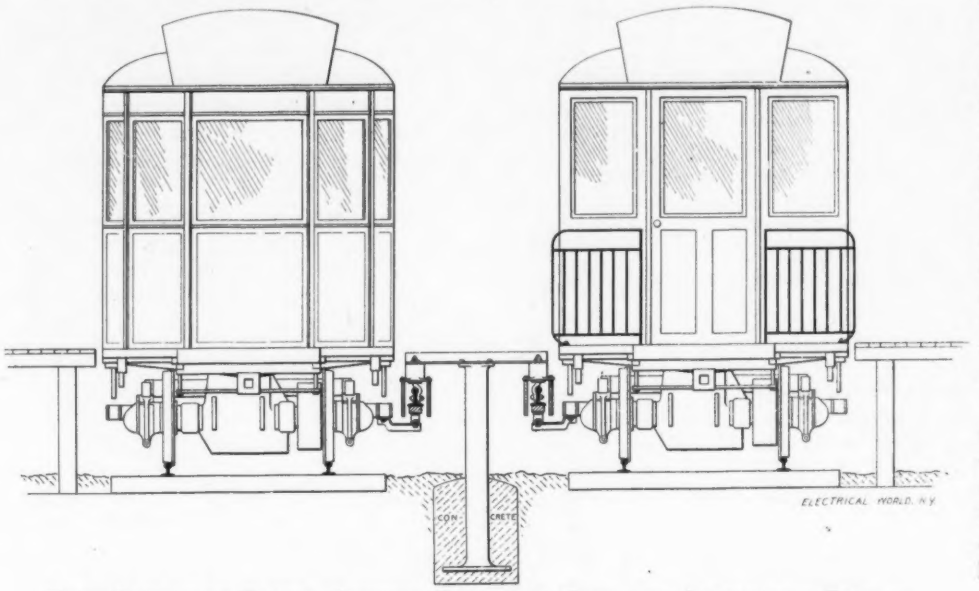
The various elements of the system will now be taken up in detail, and, after their consideration, the total cost of construction and operation and the earning power of the improvements will be briefly touched upon.

THE CARS AND MOTORS.

The cars for this service should be light and strong, somewhat smaller than the usual type of railway passenger car, and provided

with flush platforms. Cars 48 feet long, seating fifty passengers each, and weighing, loaded, 20 tons each, would be ample. The flush platforms on a level with station platform would enormously facilitate the ingress and egress of passengers and shorten the time of stoppage at stations. This point is of vast importance. The simple scheme of requiring passengers to leave the car by the forward door and enter it by the rear door could probably also be effectively carried out. In winter the cars could be heated either by a hot-water system or electric heaters operated from the main current. Air brakes of the usual pattern should be provided, with a small motor to operate the pump.

The motors should be, preferably, four in number, and of capacity sufficient to give a sustained draw-bar pull of 8000 pounds. Probably the best size would be those rated at 125 horse-power each. There is no reason why these motors should not be mounted directly upon the axles, thus eliminating at once all the difficulties of gears. A control method of the simplest variety is indicated by the conditions of service and nothing better than the series-parallel system is needed. With these motors an acceleration of 1.76 feet per second can be had with a current of about 500 amperes, and a schedule speed of 22.2 miles per hour maintained on the most difficult section of the system (the Chestnut Hill branch, where the stations average only two-thirds of a mile apart), allowing twenty seconds actual stop at each station.



CROSS SECTION OF TRACKS, SHOWING PLATFORMS, CARS, AND ALTERNATIVE FORM OF CONDUCTOR SUPPORT.

THE TRACK AND CONDUCTING SYSTEM.

The only alteration in the existing tracks necessary for the service is careful and thorough bonding, and occasional grounding to obviate the danger of shocks to workmen if the track potential should rise in dry weather. The question of the conducting system, which would be easy if the right of way was in all cases absolutely private, is rendered somewhat difficult by grade crossings. A simple and effective system, however, can be easily constructed in the following manner:

The conductor is a steel bulb rail with a flat lower flange about 5 inches wide, somewhat similar in shape to the ordinary high T rail and weighing 100 pounds per yard. This can be had in 60-foot lengths, although the calculated drop given below assumes it to be in the usual 30-foot lengths with one 0000 bond about 1 foot long at each joint. With an initial pressure of 750 volts the drop over this conductor, with a return through the tracks, similarly bonded, would be, with the train running at 40 miles per hour on a level, 35 volts per mile. The actual drop at the time of maximum acceleration, with a train halfway between two of the sub-stations to be described below, would amount to about 52 volts, or 7 per cent.

The conductors, one for each track, should be supported in the space between the double tracks in the manner shown in the illustration.

A hollow iron casting set 3 feet in the ground and surrounded by cement sustains the insulators, which carry their dependent rails at a height of 24 inches above the ties. The insulators, of porcelain, somewhat similar to those used in recent conduit work, are contained in a cast-iron cup. Upon the rail are placed hard terra-cotta tiles, of the shape shown in the detail drawings, these serving to effectually prevent accidental contact with the working conductor. The insulators are spaced 30 feet apart, the rigidity of the conductor rail being sufficient to prevent any great degree of vertical sag or movement from the upward pressure of the sliding contact in this length. A bronze shoe of about 15 inches length gives a contact area of 75 square inches, or over 1 square inch for each five amperes of current required to be taken off, assuming that two such shoes are used on each train, one on the front and the other on the rear truck.

At grade crossings, switches, etc., the conductor rail is omitted, buried copper conductors of the proper capacity taking its place. The length of a three-car train is 144 feet, so that a break of about 135 feet in the continuity of the conductor rail would not cause a rupture of the supply current or deprive a train at that point of motive power. A two-car train could pass a 70-foot break in the same way. The propriety of cross-bonding one conductor rail to the other may be open to question, because a short-circuit or accident on one track with these rails so bonded would result in a stoppage of trains on the other track of the same section, but the great value of these connections in increasing the condictivity of the system overweighs this objection. A fuse in the bond would be a sufficient precaution. With the system of sub-stations here outlined no feeders will be necessary at any point, the conductor rails being sufficient to take care of the loads of ordinary service at a comparatively small loss.

THE SUB-STATIONS.

Each sub-station would consist of a small building containing the static transformers for reducing the 500-volt supply line three-phase current to a proper pressure for use in connection with the rotary converters, booster, battery of storage cells, and the necessary switching and regulating instruments for each section of the road. The equipments of these sub-stations would necessarily differ somewhat in capacity, but in the main they would be identical.

The static transformers for the average station would have to be of about 400-kw. total capacity. It would not be advisable to put in two rotaries in each station, since the interconnection of the secondary system would permit trains to be operated over any section in the event of the temporary suspension of its sub-station. These

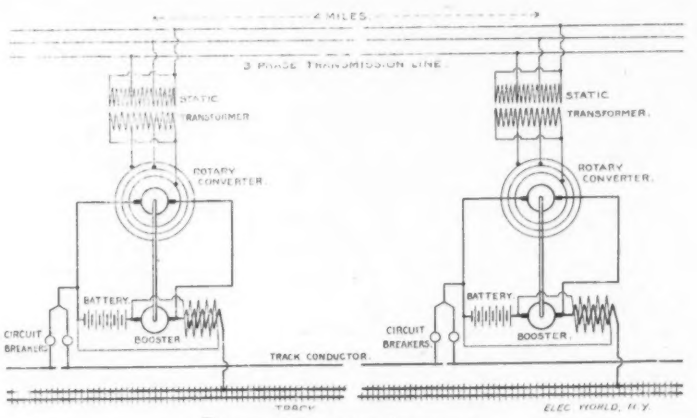


DIAGRAM OF SUB-STATIONS.

machines are capable of standing considerable overloads, and are not liable to derangement, so the factor of safety is fairly large with only one in a sub-station.

To the shaft of this rotary is mechanically coupled a booster of 40-kw capacity, which is connected, as shown in the diagram, with a storage battery of about 3200 ampere-hours' capacity. This booster is wound with a shunt field energized by the storage battery and a series field in opposition, through which the whole discharge current

flows. The effect of this, in proper balance, will be to aid the battery on discharge, and to continually supply charging-current to it when the demand from the trains on the section falls below the normal output of the rotary. By this arrangement the load upon the rotary, and consequently the demand of the sub-station upon the line, will be constant, working line, transformers, rotaries and the central station under almost ideal conditions for the highest efficiency. The field of the rotary can be compounded, if necessary, so that the wattless currents can be reduced to zero.

The sections of track assumed here are 4 miles long the breaks being on the switchboards of the sub stations, which are at that distance apart. Circuit breakers are provided, as shown in the diagram, and switches for handling the three-phase secondaries in the sub station. A convenient arrangement of the buildings would place the static transformers in an upper room. Oil circulation, water jackets, or ventilation could be easily provided if necessary. These sub stations could be conveniently combined with the block-system signal towers now used, and the same attendants could take care of both, except during the crowded hours. About 400 cells of battery should be provided at each station, mounted in paraffined wooden racks, and, of course, in a well-ventilated room separated from that containing the rotary and booster. A complete telegraph, telephone and signaling system connecting the various sub-stations and the central station should be installed. Space does not permit the discussion here of the extraordinary facility for signaling, and the operation of safety gates, semaphores, switch lights, etc., provided by the electric system, but these can be readily imagined.

THE TRANSMISSION LINE.

This line presents no features of difficulty. Structural iron poles 30 feet long, carrying cross arms and large porcelain insulators, will be required. The conductors are of bare copper wire or cable. The largest cross section required at any point, for any one division of the railway assuming a maximum drop of 20 per cent., and an average drop of 10 per cent. is 1,350,000 circular mils total, or 450,000 circular mils in each of the three conductors. While most of the right of way on which this line runs is private, certain local conditions may require parts of it to be placed in conduit, but this offers no special difficulties. The line should be kept well away from the tracks, so that it would be out of danger of destruction by a derailed train, and also to avoid the consequences of mixing 5000-volt current with a wreck in case of such a casualty.

THE POWER STATION.

The requirements of the central station are, in a sense, unique. Operating at a steady load throughout the twenty-four hours of week days, it has an opportunity of shutting down for a few hours on Sundays for necessary overhauling. The total draught of power for the system is 225,000 kw hours daily from the conductor rails. Adding the proper percentages for losses in conductors, batteries, rotaries and static transformers, this becomes 285,750 kw-hours from the transmission line, or 315,000 from the central station, assuming an average loss of 10 per cent. on the transmission line. Under steady load conditions the station should therefore have an output of about 13,000 kilowatts continuously.

This is based upon the assumption of three times as many trains as are now operated on all parts of the suburban system, providing seat accommodations for over twice as many passengers. As it is likely that the installation of the electric system will be progressive, it is advisable to provide at least two units for the generating plant. Since the adoption of electricity for the express service cannot be much longer delayed, a type of unit should be installed of such size that it will lend itself readily to this extension. These conditions seem to be met by two units, each consisting of a marine type quadruple expansion engine of about 12,000 horse power direct-connected to two 5000-volt three-phase generators of 4000 kilowatts each. Engines of this size, working under practically similar load conditions, have been in use for some time in the better class of passenger steamers, and present no unusual or difficult features. Dynamos of the size suggested are of the same class as those in use at Niagara, and can be made of high economy and great simplicity of construction.

By constructing the engines in the manner suggested in the diagram—dividing the second intermediate and low-pressure cylinders—a most perfect balance of cranks may be attained, and at the same time a divisible engine/secured, which, in case of trouble with one of the generators, may be cut apart at the centre coupling, half of it then operating one generator as a triple-expansion engine. By this arrangement nothing short of a devastating catastrophe could interfere with the continuous operation of the power house. These engines could be reasonably expected to operate on two pounds of coal per kilowatt hour output.

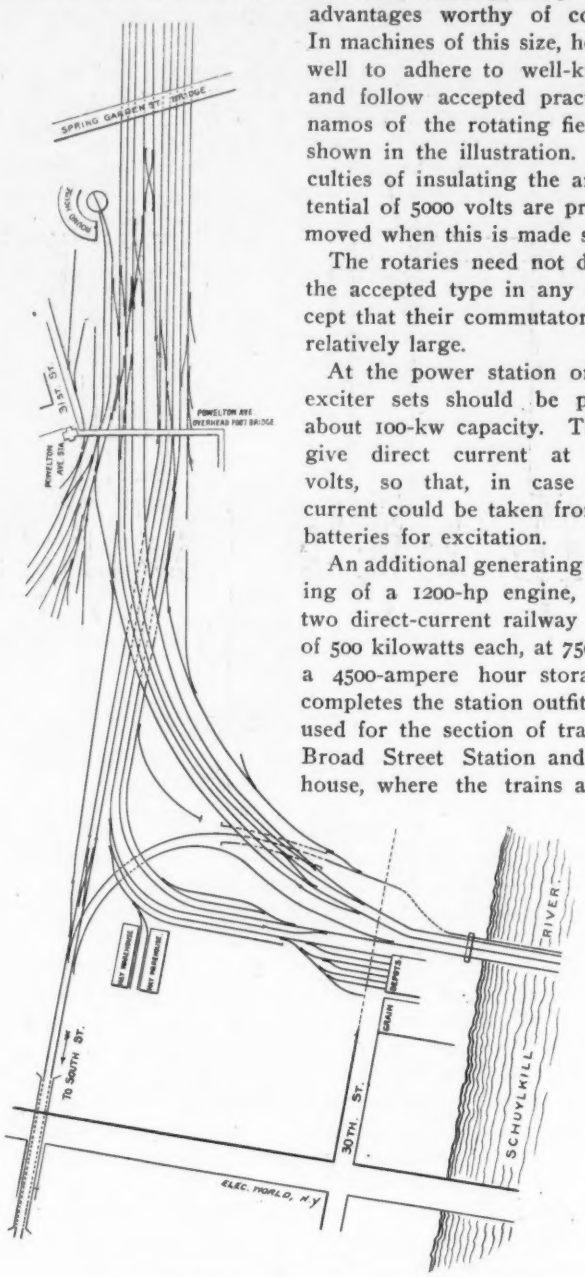
The frequency should be fairly low, about 16 to 20 cycles per second. While this will necessitate somewhat larger transformers than would be necessary with a higher frequency, it will greatly simplify the dynamos and rotaries.

A few suggestions as to the types of dynamos and rotaries may not be amiss. The inductor type of dynamo, having no moving wire or insulation, is certainly one of the most promising, and possesses many advantages worthy of consideration. In machines of this size, however, it is well to adhere to well-known types, and follow accepted practice, so dynamos of the rotating field type are shown in the illustration. The difficulties of insulating the armature potential of 5000 volts are practically removed when this is made stationary.

The rotaries need not deviate from the accepted type in any respect, except that their commutators should be relatively large.

At the power station one or more exciter sets should be provided, of about 100-kw capacity. These should give direct current at about 750 volts, so that, in case of failure, current could be taken from the track batteries for excitation.

An additional generating set, consisting of a 1200-hp engine, coupled to two direct-current railway generators of 500 kilowatts each, at 750 volts, and a 4500-ampere hour storage battery, completes the station outfit. These are used for the section of track between Broad Street Station and the power house, where the trains are thickest,



Track Centres Near Proposed Power Location.

and also feed the radiating sections diverging at Powelton Avenue and South Street. The station is, of course, located at the foot of the hill on the west side of the river, and receives its coal on the second floor level.

SPECIAL PROBLEMS.

So far the description of the system has dealt only with the features of those parts of the equipment presenting no special difficulties. There are certain troubles, however, the greater part of which are encountered in the elevated yards and approaches to the Broad Street Station. The accompanying map of the track centres gives an excellent idea of the excessive complexity of the crossings, switches and spur tracks forming these approaches. The difficulties of installing the conductor rail increase considerably in a place of this character, but they may be minimized by the simple expedient of using only the tracks in the northern side of the yard for the electric local service. This, however, does not afford a solution to the problem, because it is to be taken for granted that, in the course of time, all the tracks will be equipped with conductor rails. The discontinuity of these at

switches and crossings will cause no real trouble, except possibly in shunting single motor cars with one contact brush. These might be caught between sections, but this seems little likely. The feature that is productive of the gravest difficulty is the danger of carrying 750-volt current around a yard full of laborers and switchmen. The simplest device here, as elsewhere, is generally the best, and flooring over the whole of the most complex portion of the yard above the conductor rails would be the means most likely to satisfy all the conditions.

Grades present no features of difficulty whatever. Their effect is seen only in the arrangement of the sub-stations with reference to them.

Curves will require a modification of the protective covering for the conductor rail, presenting no great difficulty of design. Bridges will require a modified form of supports for the conductor rail. These are practically all the modifications of the standard construction described above.

PROVISIONS FOR SAFETY AND EMERGENCY.

The accident most to be dreaded in this or any other similar system is one which causes a total stoppage of traffic. The sub-division of the storage battery plant into the numerous sub-stations makes an accident of this character absolutely impossible. Even the total destruction of the central power house would leave sufficient reserve in these batteries to continue the service for a few hours and clear the tracks so that steam trains might be operated. A temporary breakdown at the power house or on the transmission line would be tided over without the least interruption to the service. A breakdown in one of the sub-stations or even its destruction would simply divide its load among its neighbors, permitting trains to be operated with but little inconvenience.

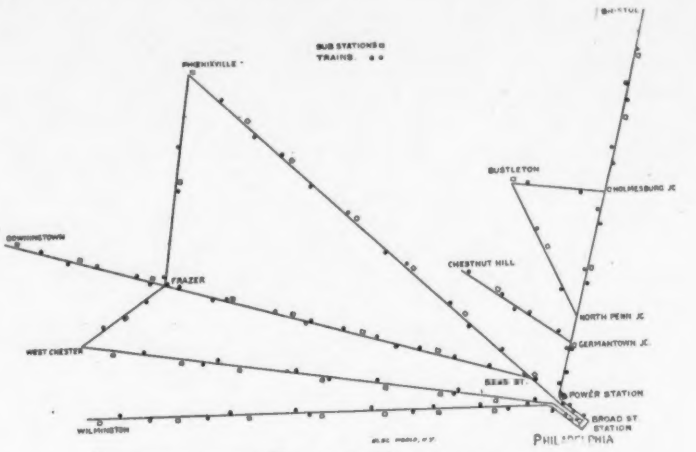
If the conductor rail is broken or displaced its continuity and the presence of sub-stations in both directions, except on the terminal section of a line, insure the presence of current. Indeed, it would be hard to render a section of the conductor rail "dead" except by cutting it in two places.

A short circuit, such as might be caused by a wreck on the line, would open the circuit breakers at two sub-stations and stop every train on the section. It thus would not be possible for a wrecked or derailed train which had caused a short circuit to be run down by another electric train. Indeed, if a train were derailed without having caused a short circuit, a convenient crowbar would furnish all the means needed for making one and obviating the possibility of a collision.

It is from the presence of the occasional fast steam express train that some danger is to be expected. The electric trains have speed enough to keep out of the way of these, and the only condition which would be dangerous would be the opening of the circuit breakers at the sub-stations, depriving an electric train of motive power. A simple system of numerous signals which would exhibit themselves if the current supply failed would be the best means of avoiding this.

The liability of derangement of the motive machinery on an electric train is not greater than in the case of a steam train. Blown fuses, damaged armatures, or broken frames are not more common than blown-out cylinder heads, broken connecting rods or leaking flues in a steam locomotive, and by the subdivision of the motor equipment into four units, much less serious. Taking into consideration all the facts it is probable that the electric service here indicated would carry passengers with less risk than any other railway system ever installed.

The safety of those whose duties require them to be much about the tracks, or those who trespass upon them, is sufficiently insured by boxing in the conductor rail. It would not take very long to instill into the minds of track-walkers, section-hands, and the like a wholesome respect for the conductor rail, while children and the ignorant public would be protected by the covering alluded to above. Of course anyone willfully tampering with the conductor would do so at his peril, but it is to be doubted if the shock from 750 volts, especially of current from a storage battery, would be fatal in any case. It would certainly not encourage a repetition of the experiment, however.



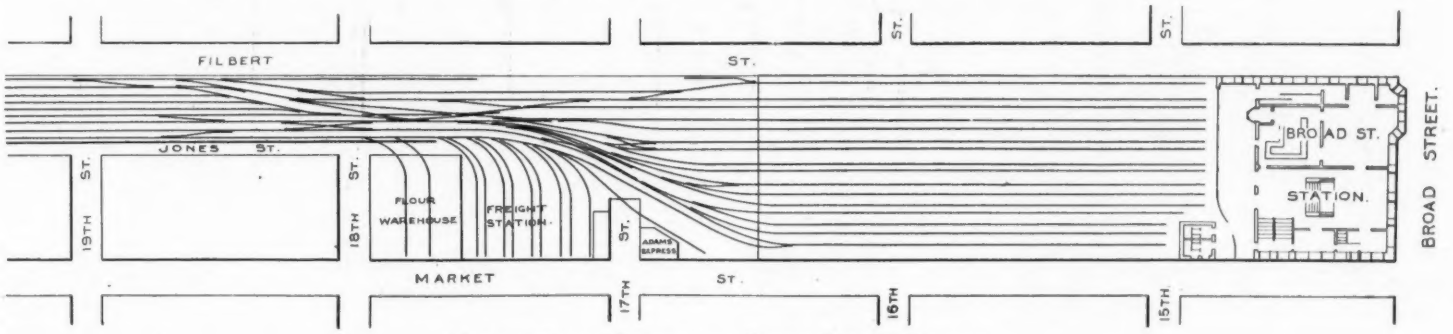
DISTRIBUTION OF ELECTRIC TRAINS AT 5:40 P. M.

COSTS OF CONSTRUCTION AND OPERATION.

It is evident that the equipment briefly indicated here will be expensive to install, but it is easy to show that it will pay its way from the beginning. It cannot, of course, be undertaken piecemeal, but at least one of the five suburban sections should be equipped throughout as the beginning of the complete equipment. Probably the Chestnut Hill branch would be the best to begin with, since it combines heavy service, considerable grades and frequent stops, and would furnish an admirable test of the qualities of the electric system, and be an excellent field for experiment.

Assuming the total equipment as here outlined to be installed, the costs will be approximately as follows:

The steam engines, together with their boilers, condensers and other appurtenances, can be had for about $700,000. The four large dynamos, two small dynamos, switchboards, exciters, etc., would cost about $600,000, which would make the total cost of the central station, including land, buildings and equipment, about $1,500,000.



MAP OF TRACK CENTRES AT BROAD STREET STATION.

The sub-stations would each contain 400 cells of storage battery of 3200-ampere hours' capacity each, costing about $80,000 installed in place. The rotary transformers and booster can be installed for about $10,000. The switchboard and instruments would cost about $2000, and the static transformers about $8000. The cost of land and buildings would bring the total for each sub-station up to about $110,000.

The transmission line consists of about 155 miles of pole line, for which the iron poles set in cement, and complete with insulators would cost about $225,000. The copper would cost about $85,000, or say $90,000 in place, on a basis of 10 per cent. loss. The track conductors are 320 miles long, weigh 27,520 short tons, and will cost, in place, including bonding, the tile covering and the insulators, about $1,400,000.

The motor equipments for the 160 trains necessary for full service would cost about $10,000 each, or $1,600,000. The cost of the car bodies is not included in this estimate, since the seating

capacity to be provided would be the same whatever the motive power used. It is fair, however, to include a sum of $300,000 for the extension of the present car service, the alteration of cars and the building of platforms.

Recapitulating the whole we have as totals:

Power house	$1,500,000
40 sub-stations	4,400,000
Transmission line	315,000
Conducting system	1,400,000
Motors and extra cars	1,900,000
Total	$9,715,000

or in round numbers $10,000,000.

Turning now to operating expenses, it is seen at once that a large saving will result. The expenses of the power station for coal, water and oil, may be set at $360,000 annually. For wages, the annual expenditure would be about $25,000, it being assumed that mechanical stoking is used. The expenses of the sub-stations would be dependent upon the possibility of combining them with railway stations, signal towers, or the like, but would probably average about $7,000 annually, each, for wages, and about $2,000 for oil and supplies, making a total of $360,000. Hence, exclusive of interest and repairs, the annual motive-power cost would be about $750,000 in round figures.

Repairs can be fairly figured at 5 per cent. on the power station, 7 per cent. on the sub-stations, 4 per cent. on the transmission line, 4 per cent. on the conducting system and 8 per cent. on the motors, etc., giving a grand total of $605,000 annually.

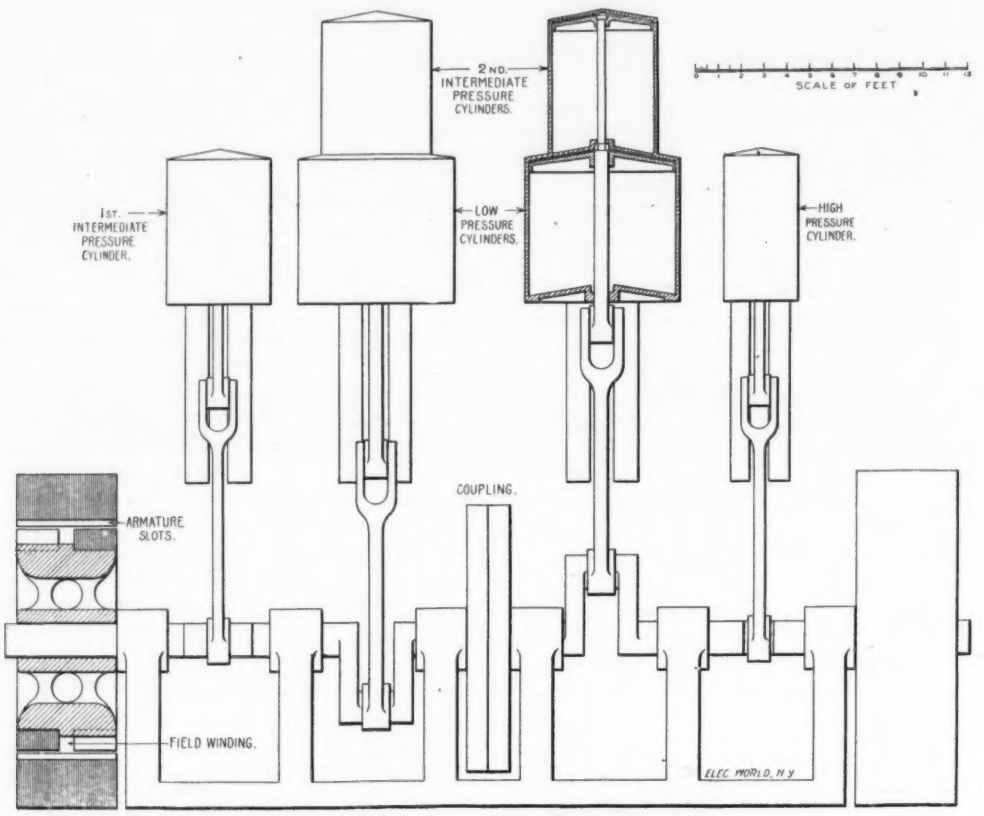
The trains can be operated by two men on each, a driver and conductor. The crews required will number, including extra men, etc., about 300, with wages at about $1,300 a year for each, or $390,000. This gives for the total costs of operating the trains, exclusive of interest, $1,745,000 annually, or, including interest at 5 per cent., $2,245,000.

The total annual mileage of these trains will be 9,706,000, showing an average cost of a little more than 23 cents per train mile. If the expense of manning the trains is omitted, this figure becomes 20 cents.

No estimate has been included of the depreciation and repair of the permanent way and stations. It would be impossible, even if figures were at hand giving the annual items, to differentiate the charges properly due to the steam long-distance service from those due to the electric local trains. It can be clearly seen, however, that while increased traffic might slightly increase the expense of maintaining stations, the substitution of motor cars weighing 32 tons for locomotives weighing 50 tons would decrease the track maintenance cost, even when three times as many trains are run. It is the "hammering" of the heavy reciprocating parts of the locomotives that wears out the tracks, and their life when traversed by motor-driven wheels would be greatly lengthened—how much experience alone can decide.

It is proper to add that the figures here given make no pretense to accuracy, but are to be regarded as rough first approximations, interesting only as comparisons. It is utterly impossible to calculate the traffic of the system, but an approximation of the earning power of the system may be made on the basis of the following assumptions:

If it assumed that each train starts from Philadephia with its full complement of passengers, and discharges them at intermediate stations so that it reaches its terminus practically empty, and that this process is reversed on trains running into Broad Street, it is fair to assume the annual capacity to be about 32,000,000 passengers. Assuming that these travel an average of 10 miles each, the total passenger mileage capacity will be 320,000,000, which will result in a gross revenue of $3,200,000 at a rate of 1 cent per mile. This leaves a net earning capacity of about $1,000,000 per annum.



A Suggestion for the Generating Units.

CONCLUSION.

The system here briefly presented lays no claim to special originality or merit, but is given as an illustration of the perfect ability of present day electrical engineering to cope with the problems presented by steam-railway service under peculiarly difficult conditions. It required no great gift of prophecy to foresee the electrical equipment of this and other similar suburban services in the near future. It has been intended throughout this paper to offer simple and feasible plans, rather as suggestions than as final designs for such a system, and to attempt to show that the electrical equipment of this railway is neither impossible nor chimerical. The alluring problem which such an installation offers to electrical engineers, the beauty of the systems which may be devised to meet the exigencies of each special case, the magnitude of the works which must be inaugurated almost immediately, and the absolute precision and certainty with which results may be predicted, conspire to render the beginning of the new era in railroading one of the most fascinating subjects with which recent progress has made us acquainted.

Electric Power for Operating Printing and Binding Machinery—II.

BY REED R. BISHOP.

1st. The motor placed under the press, either on a separate base or attached to the frame of the press, and connected to the driving shaft by means of gears.

2nd. The armature mounted directly on the shaft of the press, and therefore placed at the side of the press.

3rd. The motor placed at the side of the press on a separate base and comunicating its motion by means of gears.

The advantages of the first method are:

(a) Since a standard type of motor is used, its first cost and the cost of repairs will be less than those of a specially wound motor.

(b) In case of a break down in the motor, new parts can be readily secured to replace the injured ones, or a new motor may be substituted, and thus the work of the press will be interrupted only for a very short time; whereas, in the case of the specially wound motor, much time would be lost and great inconvenience caused if a break down should occur.

(c) The space occupied by such a motor placed under the press is not available for other purposes; whereas, when the armature is mounted directly on the shaft, the motor must be placed at the side of the press and thus occupy valuable floor space.

(d) The standard motor is a more efficient machine than the specially wound slow-speed motor. The $C^2 R$ losses in the specially wound slow-speed motor will be about equal to the friction losses in the standard motor and the gears by means of which it is connected to the driving shaft of the press.

The noise caused by the connecting gears may be urged as a disadvantage of this method. In this plant raw-hide pinions on the motors are used exclusively, and the smoothness of action and noiselessness of the gearing are quite remarkable. The noise due to the reversals of the heavy reciprocating parts of the presses is considerable, and this fact may account in part for the apparent noiselessness of the gears.

The motor placed under the press is inaccessible and difficult to get at when repairs are required or adjustment necessary.

As advantages of the second method may be mentioned:

(a) There is less friction loss in the motor, and the friction loss in the connecting gear is entirely obviated.

(b) Increased simplicity of construction.

(c) Absence of connecting gears secures noiseless running.

(d) The motor placed in this manner occupies less space than where, as in the third method, the motor is placed on a separate base outside the frame of the press.

(e) The life of the motor will probably be greater, due to its slow speed.

TABLE II.—TESTS OF PRINTING-PRESS MOTORS.

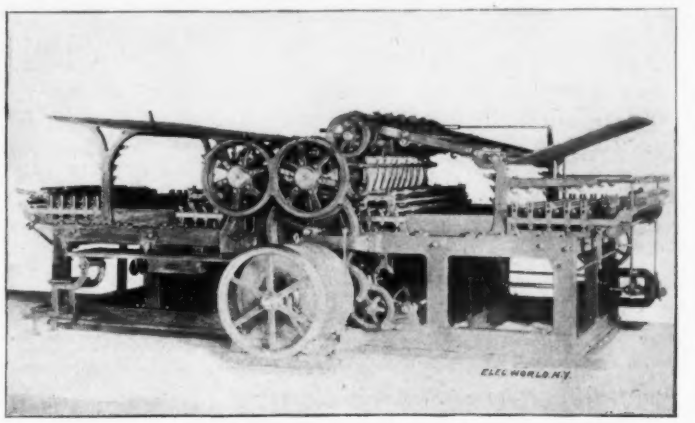
No. of press.	Amperes.	Volts.	Watts.	Rate sheets per minute.	Watt-hrs. per 1000 sheets.	Size of sheets.	Form.	H.P.	Rated h.p. of motor.	Sheets per h.p.-hour.	Controller.
1	16	110	1760	21	1400	42 in. x 60 in.	Light	2.36	5 L	530	7
2	19	109	2071	22	1570	42 in. x 60 in.	Medium	2.78	5 L	470	G.S.
3	16.5	108.5	1740	22	1360	16 in. x 22 in.	Light	2.40	3 L	550	5
5	16.5	110.5	1823	27	1130	30 in. x 40 in.	Medium	2.44	2 L	660	G.S.
6	16.7	109	1820	22	1380	30 in. x 42 in.	"	2.44	2 L	540	4
7	17	110	1870	26	1200	31 in. x 40 in.	Heavy	2.50	2 L	620	G.S.
8	12.5	109	1362	Free	.....	31 in. x 38 in.	"	1.83	2 L	...	....
9	16.5	111	1831	26	1180	26 in. x 34 in.	Medium	2.45	2 L	630	5
10	14.5	111	1609	28	960	31 in. x 38 in.	"	2.14	2 L	790	G.S.
12	13.7	112	1530	29	880	30 in. x 42 in.	"	2.05	2 L	850	G.S.
13	20.7	110.5	2293	18.5	2070	36 in. x 50 in.	Heavy	3.07	7½ L	360	2
14	17	112.5	1912	20.5	1560	31 in. x 41 in.	Light	2.56	3 L	480	5
15	13	111	1443	20	1200	30 in. x 42 in	Heavy	1.93	3 L	620	G.S.
16	12	108	1296	14	1540	30 in. x 42 in.	"	1.74	3 L	480	....
17	31	109.5	3394	21	2690	36 in. x 49 in.	Medium	4.55	7½ L	280	4
18	28.3	109.5	3093	20	2580	27 in. x 37 in.	Light	4.15	7½ L	290	7
19	20	109	2180	14	2600	60 in. x 77 in.	"	2.92	7½ B	290	1
19	23	109	2507	20	2090	60 in. x 77 in.	"	3.36	.....	360	2
19	26	108	2808	21	2230	60 in. x 77 in.	"	3.76	.....	340	G.S.
20	20	109	2180	22	1650	30 in. x 43 in.	Medium	2.90	7½ B	460	....
21	12	110	1320	19	1160	30 in. x 48 in.	Light	1.77	4 B	640	1
22	10	108	1080	27	Free	....	....	1.45	4 B	...	1
22	14	109	1526	46	Free	....	....	2.05	... ..	...	2
24	15	109	1635	18	1510	32 in. x 30 in.	Heavy	2.19	3 B	490	G.S.
25	12.5	109.5	1368	21	1090	25 in. x 42 in.	Medium	1.83	3 B	690	1
25	14	103	1526	24	1060	25 in x 42 in.	"	2.05	.....	700	2
25	16	109	1744	27	1080	25 in. x 42 in.	"	2.34	.....	870	G.S.
26	9.8	112	1098	22	830	30 in. x 42 in.	Light	1.47	3 B	900	1
26	10.5	112	1176	24	820	30 in. x 42 in.	"	1.58	.....	910	2
26	11.5	112	1288	27	800	30 in x 42 in.	"	1.73	.....	940	G.S.
27	19	109	2071	18	1920	22 in. x 30 in.	Medium	2.77	4 B	390	3
28	19.5	109	2125	19	1860	30 in. x 45 in.	"	2.85	4 B	400	1

The third method, in which a standard type of motor is placed on a separate base outside the frame of the press, has all the advantages of the first method, except (c), and has the additional advantage of being perfectly accessible.

It has the disadvantage of occupying more floor space than either the first or second method, but there seems to be no available space underneath certain makes of presses, and, further, when the space occupied by the motor is compared with that occupied by the press itself, the above disadvantage becomes of little importance.

EXPLANATIONS AND REMARKS ON TABLE II.

In each of the tests recorded in this table a Weston ammeter was placed in the motor circuit, a Weston voltmeter across the mains supplying the motor, and readings of these instruments, together with the number and size of sheets printed per minute, were noted during the regular working of the press, hence the results and conclusions apply to the ordinary conditions of practical working. The instruments were carefully calibrated at the Weston laboratory immediately before the tests were made, and it is thought that the readings are as accurate as possible under the conditions.



BULLOCK MOTOR AND COTTRELL PRESS.

Due to the reciprocations of the heavy type bed, the value of the current taken by the motor varied according as the type bed was being accelerated or retarded; hence, it was impossible to read directly the exact value of the current, but the values given are the mean values in every case.

For the benefit of those not familiar with the terms, "heavy form," "medium form" and "light form," as used by the printer, it may be stated that a "form" is an assemblage of type, or of type and plates, secured in a chase ready for printing. The term is also applied to the printed sheet or impression produced by the assemblage of type, and, referring to this latter signification, it may be said that the character of the form depends upon the ratio of the inked surface to the blank surface on the printed sheet. If this ratio were infinity the printed sheet would be perfectly black, and with the ratio zero the sheet would be entirely white. In practical working these limits are narrowed down very much, and it is sufficient for the present purpose to say that a "heavy form" is one in which the letters are small and very close together, or one in which there are many pictures, or, as in many primary school books, where entire pages are printed in black, the letters only being left in white. Great pressure must be exerted on a form of this kind to bring out the details distinctly; hence the press must run slowly and the number of sheets per horse-power hour will be reduced. A "light form" then, is one in which there is little printed matter on a page, no pictures, the letters widely separated from each other and having wide margins. A "medium form" is anything between heavy and light. The character of the form has such wide variations and varies with such a vast number of gradations that no attempt has been made to take this factor into careful consideration.

The viscosity of the ink is also a variable factor which has some influence upon the power required to operate the press. The above definition of "form" would lead one to think that colored maps constitute a very heavy form. On the contrary, since the colored inks are much thinner than the black, and so much less adhesive, a form consisting of colored maps is said to be "light." It is evident, also, that the power required to operate the press will vary with the size of the sheets printed. In the limited time at the disposal of the author it was impossible to even attempt to show to what extent the power required by the motor varies with these factors.

From the columns "H. P." and "Rated H. P. of motor," it is seen that several of the motors are working at much less than their rated

capacity. This is largely accounted for by the fact that when the machinery was first installed the power required to operate it was much greater than at the present time, in some cases being as much as 50 per cent. greater. This great decrease in the amount of power consumed is probably due to the fact that the machines now operate with much less friction than when new, and it is also likely that the parts are now in more perfect adjustment, and that the workmen are more accustomed to handling the machines. The workmen sometimes carelessly use the main switch instead of the rheostat in starting, and the consequence is that the starting current is very large—sometimes two or three times its normal value. Hence it is evident that the series motor is best adapted for this severe service, since the self induction and resistance of its field coils tend to keep down the rush of current on starting. The starting current is large even when a legitimate method of starting is employed, due to the heavy reciprocating parts to be accelerated.

In the last column, headed "Controller," is given the point at which the rheostat arm was placed at the time the readings were taken. The letters "G. S." (greatest speed) indicate that all the resistance of the rheostat was cut out, and that the motor was operating at its highest speed.

In the column headed, "Rated H. P. of Motor," the letter "L" indicates that the motor is a standard Lundell motor, while the letter "B" indicates a Bullock motor.

The following list is tabulated to afford a means of comparing the various makes and sizes of presses and the two methods of connecting the motors:

	Average sheets per H. P. hour.
Miehle No. 0000, 5 horse-power motor, geared	500
" No. 00, 2 or 3 horse-power motor, geared	663
" No. 00, 3 horse-power motor, direct connected	720
" No. 000, 4 horse-power motor, direct connected	640
Hoe No. 8, 7.5 hore-power motor, geared	360
" No. 7, 3 horse-power motor, geared	527
" No. 7, 4 horse-power motor, direct connected	395
Cottrell, 7.5 horse-power motor, geared	570

The figures in the column headed "Average Sheets per H. P. Hour" were obtained by taking the average of all the determinations of column 11 of Table II. for each particular combination of press and motor: Since the Cottrell press is a perfecting press, printing both sides of the sheet at one operation, its work is equivalent to that done in two operations by any of the other presses. Hence, the number of sheets per horse-power hour obtained from the tests of presses Nos. 17 and 18 has been multiplied by two in order to obtain a figure comparable with those above for the other presses.

As previously stated, the number of printed sheets produced per horse-power hour by any combination of press and motor will depend largely upon the form, the size of the sheets printed, and the viscosity of the ink, and since these factors have not been considered in deducing the above figures, we are not justified in drawing conclusions from them as to the relative merits of the presses of the different manufacturers or of the two methods of operating presses by means of motors.

The experiments seem to indicate that the Miehle No. 00, with the armature mounted directly on its driving shaft, will produce more printed sheets per horse-power hour than the same press with a geared motor. This, however, is not in accordance with the results found by other experimenters.

Again, the experiments indicate that the No. 7 Hoe press, with a geared motor, is a more efficient combination than the same press with a direct-connected motor. Hence, further experimenting and observation are necessary before any attempt is made to state finally whether it is more economical to operate the press by a standard motor with gearing, or by a specially wound slow-speed motor, with its armature mounted directly on the driving shaft of the press.

Table III.—Data for Bindery—Sixth Floor.

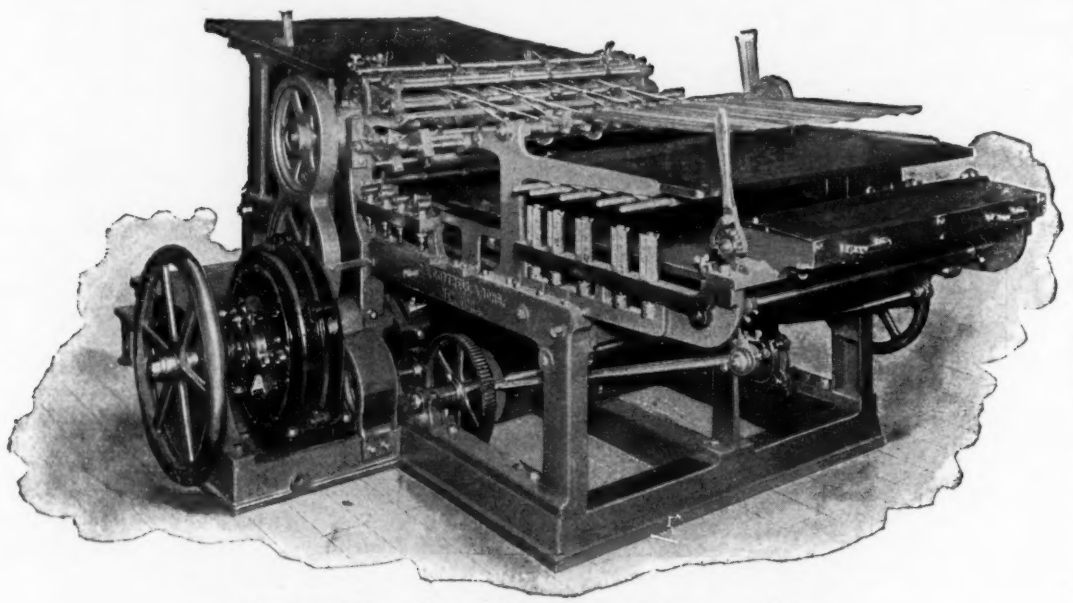
Name of machine.	H.P. of motor.	Type of motor	How mounted.	How connected.	Method of control.
Chamber's quadruple folder (50 in.)	1	Series	On frame of machine.	Geared.	Rheostat.
Chamber's "double 16" folder	½	"	"	"	"
Hickok signature press	2	Diff.	On base bolted to frame.	"	Starting box.
Sanborn 48-in. cutter	1	"	"	"	"
Sanborn 34-in cutter	1	"	"	"	"
Singer sewing machine	⅛	"	On frame of machine.	"	Rheostat.
Universal wire stitcher	1	"	Separate base.	Belted.	Starting box.
Crawley & Johnson pasting machine	½	"	On frame of machine.	Geared.	"
Smythe book-sewing machine, No. 3	1	Shunt.	.....	Line shaft and belts	Rheostat.
Smythe book-sewing machine, No. 101	½	"	.....	"	"
Circular saw	¼	Diff.	On frame of machine.	Geared.	"
Sanborn smashing machine	1	"	"	"	Starting box.

BINDERY.

In Table III. is presented a list of machines installed on the sixth floor. It shows also the size of motor used to drive each machine, type of motor used, method of control, etc. A large percentage of the motors on the fourth, fifth and sixth floors are furnished with Cutler-Hammer automatic starting boxes.

Four No. 1 Smythe book-sewing machines are operated by a line shaft, which is connected by a rigid coupling to the shaft of a one-half horse-power shunt motor.

Twelve No. 2 Smythe book-sewing machines are also operated in a group by a second line of shaft 60 feet long by 1 3-16 inches in diameter. The machines are mounted on a platform, raised about 6 inches from the floor, and the shaft is placed under this platform, each machine being belted to the shaft, and being thrown in or out of gear by means of an idle pulley. The line shaft is attached by means of a rigid coupling to the armature shaft of a 1-hp Lundell shunt-wound motor, running at a speed of 1300 revolutions per minute.



Lundell Motor Direct-Connected to Cottrell Press.

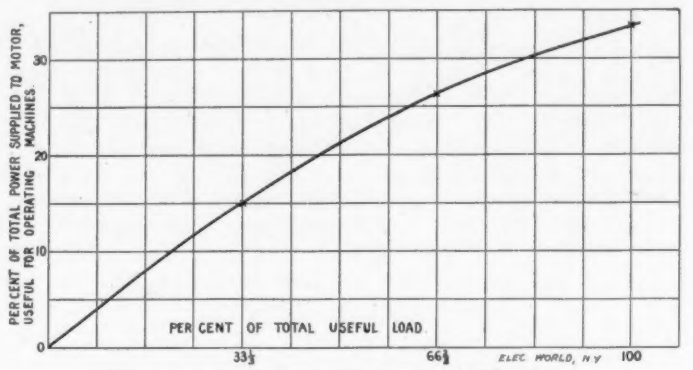
Hence we have a strong argument in favor of the use of individual motors, instead of operating several machines in one group by means of a line shaft. In this particular case, however, since the total amount of power used by the twelve machines is small, there is little doubt of the advantage of this method of operating the entire group by one motor and line shaft. The advantages of a single motor and line shaft over individual motors for this particular case are as follows:

(a) A motor of at least one-sixth horse-power would be required for operating each of these machines individually, and the first cost for motors would be about three times as great as for a single motor to do the same work.

TABLE IV.—TEST OF LINE SHAFT MOTOR.

Load on the motor.	Amps.	Volts.	Watts.	H.P.
Shaft and belts only	2.5	100	250	.33
Shaft, belts, and four sewing machines	3.	98	294	.39
" " " eight " "	3.5	97	339	.45
" " " twelve " "	4.	94	376	.49

Watts required to drive shafting plus stray power losses in motor 250
Total watts at ⅓ load 204
Consumed by shafting and stray power in motor ... 170/204 .85 or 85 per cent.
Total watts at ⅔ load 330
Consumed by shafting and stray power in motor ... 242/330 .735 or 73.5 per cent.
Total watts at full load 376
Consumed by shafting and stray power in motor ... 250/376 .665 or 66.5 per cent



CURVE SHOWING PERCENTAGE OF USEFUL LOAD.

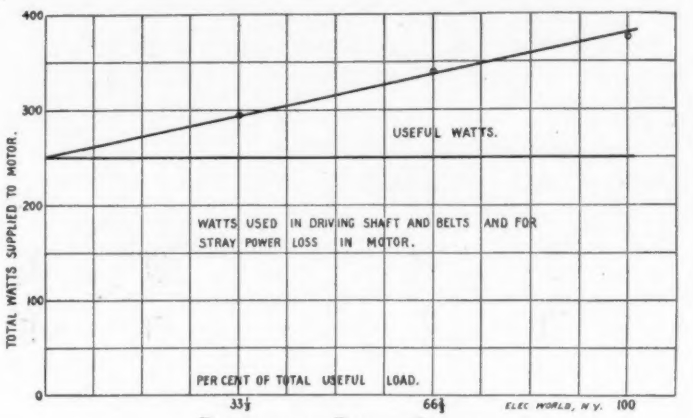


DIAGRAM OF POWER LOSSES.

(b) The aggregate losses in twelve motors of this small size would be much greater than the stray power losses in the 1-hp motor, plus the friction loss in the line shaft.

(c) There would be twelve motors to look after instead of one, and each of these twelve would require more attention than is required by the one horse-power motor.

(d) By the use of the line shaft a uniform speed of the different machines is secured, whereas it would be practically impossible to make the twelve small motors run at the same speed.

(e) The cost for repairs and maintenance for the twelve motors would be much greater than for the 1-hp motor.

The Hickok signature presses are each connected by gearing to a 2-hp differentially wound Lundell motor. The current for starting was about 15 amperes, but this immediately dropped to 1.8 amperes when the motor had reached its full speed. As the pressure increased, the current taken by the motor gradually rose to 10 amperes, at which point the circuit was automatically broken. The total pressure exerted on a bundle of signatures is 26,000 pounds.

The circular saw has nine blades, and is used for sawing out the cross slits in the backs of books, for laying in the backing cords when sewing the sections of a book together.

The "power transmitter" used for connecting the motors to the Hickok rulers is a device for reducing the speed, the ratio of reduction in this case being 37 to 1. These rulers are used for ruling copy books. The "Double Ruler" rules both sides of the sheet, in one direction only, while the "Quadruple Ruler" rules both sides of the sheet, and in both directions, at one passage of the sheet through the machine.

The manufacturers of the Quadruple ruler claim that it is entirely practicable to rule ninety reams of paper per day of ten hours with this machine. This is equivalent to a working speed of seventy-two sheets per minute. At the time of the test of the

TABLE V.

Machine.	Amps.	Volts	Watts.	H.P.	Rated H.P.	Speed of motor.	Rate of working.	Remarks.
Quadruple folder	4.4	110	484	.65	1	1300	48 sheets per minute.	Sheets 34 in. x 50 in.
"Double 16" folder	2.6	110	286	.38	½	1550	48 sheets per minute.	Running free
Hickok signature press	1.8	112	201	.27	2	1000		" "
Hickok signature press	10.	112	1120	1.5	2	.....	.....	Pressure 13 tons
48-in. cutter	4.	110	440	.58	1	1300	.....	No load
" "	13.	109	1417	1.9	1	.....	.....	Cut 3 in. x 44 in.
34-in. cutter	9.5	108	1026	1.4	1	1300	.....	Cut 2 in. x 30 in.
Sewing machine.	1.6	110	176	.23	⅛	140	.....	.....
Wire stitcher	2.2	109	240	.32	1	.....	.....	Running free.
Pasting machine.	1.	110	110	.17	½	1550	29 sheets per minute.	.....
12 book-sewing machines	(See Table III.)				1	1300	48-50 sig. per minute.	.....
4 book-sewing machines	1.2	111	133	.10	½	1550	.....	3 machines running
Circular saw	.8	106	84.8	.11	¼	2100	.....	Running free
" "	6.	106	636	.85	¼	.....	.....	Moment of cutting
Smashing machine	1.	108	108	.16	1	1300	28 per minute	.....

TABLE VI.—DATA FOR BINDERY—FIFTH FLOOR.

Name of machine.	Type of motor.	H.P. of motor.	How mounted.	How connected	Method of control.	Speed.
Seybold automatic trimmer	Diff.	2	Separate base	Gear	C. & W. controller	.....
Sanborn book trimmer	"	½	" "	"	Rheostat	.....
Crawley rounder and backer	Series	½	" "	"	Starting box	.....
Case roller	Diff.	½	On floor	Belt	" "	1550
Smythe case maker	Shunt	1	Separate base	Gear	" "	1310
Seybold embosser	Series	1	On floor	"	" "	1900
Sanborn stamper	Diff.	1	On frame of machine	"	" "	.....
Colt inking presses	"	½	On floor	"	" "	1550
Sanborn board cutting machine	.....	½	On frame of machine	"	" "	1550
Sand-papering machine	Series	1	Separate base	"	" "	.....
Sanborn book trimmer	Diff.	¼	On frame of machine	"	" "	1700

TABLE VII.—TESTS OF MOTORS ON FIFTH FLOOR.

Name of machine.	Amps.	Volts.	Watts.	H.P.	Rated H.P.	Remarks.
Seybold automatic trimmer	7	110	770	1.03	2	.....
Sanborn trimmer	3.9	110	385	.51	½	Cut 7 in. x 2½ in.
Cawley rounder	2	109	218	.29	½	.....
Case roller	1.8	110	198	.26	½	.....
Smythe case maker	1.1	110	121	.18	1	Running free
" " "	3	110	330	.44	1	.....
Seybold embosser	3.8	112	426	.47	1	18-24 covers per min.
Sanborn stamper	1.2	107	128	.17	1	.....
Colt inking press	1.8	110	198	.26	½	.....
Board cutter	.9	110	99	.13	½	Running free
" "	1.	110	110	.15	½	Cutting
Sand-papering machine	6 3	103	649	.87	1	.....
Sanborn trimmer	.6	108	65	.09	¼	Running free
" "	1.2	108	130	.18	¼	Cutting cloth

TABLE VIII.—MACHINES INSTALLED ON FOURTH FLOOR.

Name of machine.	H.P. of motor.	Type of motor.	How mounted.	How connected.
Brown & Carver 38-in. cutter	1	Shunt	On floor	Geared
Two Smythe wire stitchers	½	"	"	Belted
Hickok double ruler	¾	Series	"	"Power transmitter"
Hickok quadruple ruler	1	"	"	" "
Braidwood copybook folder	½	Shunt	On frame of machine	Geared
Tiddy circular saw	2	Series	On floor	Belted

TABLE IX.—TESTS OF MOTORS ON FOURTH FLOOR.

Name of machine.	Amps.	Volts.	Watts.	H.P.	Rated H.P.	Speed of motor.	Remarks.
38-in. cutter	1.6	111	178	.24	1	.....	Free
" "	9.5	110	1045	1.4	.....	.....	Cutting
Quadruple ruler	4.8	111	534	.73	1	1670	Free
" "	6.1	111	677	.89	.....	.....	With load
Braidwood folder	.9	110	99	.13	½	.....	Free
" "	1	110	110	.15	.....	.....	Full load
Circular saw (In basement.)	13	110	1430	1.9	2	975	.....
Knife grinder	6	112	672	.89	3	.....	Free
" "	22	106	2332	3.1	.....	.....	Grinding

Quadruple ruler its working speed was about fifty sheets per minute.

The power used by the circular saw depends largely upon the rate of feeding the lumber to be cut. At the time of the test the saw was cutting a 1 3-8 inch ash plank. The speed of the saw is 3500 revolutions per minute.

In the sub-basement there is a Seybold automatic knife grinder, connected by means of a belt to a 3-hp differentially wound Lundell motor. The test of this motor is given in table 9. As in the case of the circular saw, the power required to operate the knife grinder depends almost entirely upon the pressure with which the knife is held against the stone.

The following tests were made with the object of determining accurately the amount of power used by the electric elevators. A Thomson recording watt-hour meter was put in the circuit with the elevator motor to be tested, and readings were taken every twenty-four hours. Each elevator is furnished with a cyclometer, which registers the miles traveled by the car. Cyclometer readings were also taken every twenty-four hours. The cyclometer registers only as the elevator is going up, hence the difference between the consecutive readings is to be multiplied by two to obtain the number of miles per day traveled by the car. The results of the tests are tabulated as follows in Tables X and XI:

Table X. Passenger Elevator.

Date, April.	Wattmeter Reading.	Diff.	Watt Hours.	H.-P. Hours.	Cyclometer Reading.	Diff.	Miles p. day.	H.-P. hrs. per car mile
4	158,900				890.25			
5	177,250	18,350	27,525	36.90	897.75	7.5	15	2.46
6	195,080	17,830	26,745	35.85	905.	7.25	14.5	2.47
7	213,520	18,440	27,660	37.08	912.5	7.5	15	2.47
8	231,530	18,060	27,090	36.32	920.	7.5	15	2.42
9	249,550	17,990	26,955	36.14	927.5	7.5	15	2.41
10	265,550	16,000	24,000	32.18	934.25	6.75	13.5	2.38
12	282,780	17,230	25,845	34.65	941.	6.75	13.5	2.56
13	300,760	17,980	26,970	36.16	948.25	7.25	14.5	2.49
14	317,500	16,740	25,110	33.67	955.25	7.	14.	2.40
15	335,920	18,420	27,630	37.04	962.25	7.	14.	2.61
16	352,820	16,900	25,350	33.98	969.25	7.	14.	2.43
							Mean....	2.46

Table XI. Freight Elevator.

Date, April.	Wattmeter Reading.	Diff.	Watt Hours.	H.-P. Hours.	Cyclometer Reading.	Diff.	Miles p. day.	H.-P. hrs. per car mile.
19	475,800				580.25			
20	489,000	13,200	19,800	26.55	586.25	6.	12.	2.21
21	403,970	14,970	22,455	30.10	592.25	6.	12.	2.51
22	416,300	12,330	18,495	24.79	597.5	5.25	10.5	2.36
23	423,740	7,440	11,160	14.96	600.	2.5	5.	2.99
28	427,740	4,000	6,000	8.04	601.25	1.25	2.5	3.21
30	441,850	14,110	21,165	28.37	607.	5.75	11.5	2.46
5/1	448,900	7,050	10,575	14.18	610.	3.	6.	2.36
							Mean....	2.58

The lack of uniformity in the horse-power hours per car mile for the different days in the test of the freight elevator is probably due to the fact that the loads carried by this elevator varied considerably, whereas the average load of the passenger elevator for the different days was quite constant. These three elevators are alike in every respect, and each is designed to carry 2500 pounds at a speed of 250 feet per minute. The cars weigh 2700 pounds each, and are counter-balanced, so that the motor is only required to lift one-half the weight of the car. The diameter of the drums carrying the cables is 40 inches. Eickemeyer motors are used, and their speed is 1250 revolutions per minute. The current required for starting is 150 amperes.

Much credit is due the designer of this plant, the well-known engineer, Mr. George Hill. To him belongs the distinction of having installed and carried into successful operation the first plant for the production of a complete book by means of machinery driven by individual electric motors. Previous to the time when this installation was undertaken by Mr. Hill many of these machines had not only never been operated by electric motors, but in many cases no tests had been made to determine the amount of power required to operate them. Some machines for which the manufacturers advised the use of 5-hp motors are being operated with perfect satisfaction by ½-hp motors. Hence the magnitude of the task undertaken and so successfully accomplished by Mr. Hill is evident.

In concluding this paper the author wishes to express his appreciation of the courtesy with which he was received by the officers of the American Book Company, and to acknowledge his indebtedness to Chief Engineer Huckins and his assistants for their co-operation in the work above recorded, also to Mr. Christopher Van Deventer for his assistance in the practical testing at the plant and in tabulating the results.

The author regrets that the limited time at his disposal would not permit him to make a more thorough observation of the machinery in the bindery; but it is hoped that the tabular matter here presented will be of use to those who anticipate the installation of electric motors for work of this nature.

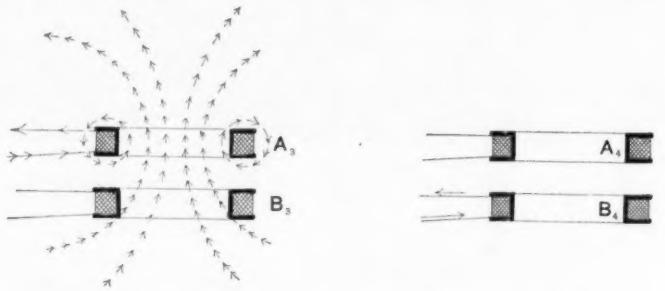
Alternating-Current Machinery—XVIII.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

MUTUAL INDUCTANCE.

154. If a coil A, Fig. 102, has a mutual inductance of L^u henrys with an open-circuited coil B_1; then, when a current of i amperes flows around A_1, there will be linked with the circuit of B_1, by definition, a magnetic flux linkage of $\varphi = i\, L^u \times 10^8$ weber-turns. (Sec. 149). If the current i, instead of being steady, is sinusoidal, or of the simple alternating type, it may be expressed $i = I \sin \omega$ amperes, where I is the amplitude (Sec. 11) in amperes, ω the angular velocity (Sec. 24) of the alternation in radians per second, and t the time in seconds from some instant at which the current passes through zero in the positive direction. Consequently, $\varphi = I\, L^u \sin \omega\, t \times 10^8$ weber-turns. This linkage may be regarded as the flux in webers which would virtually pass through the circuit B_1 if the latter consisted of but a single loop, when an alternating current passes through the winding of A_1. This flux alternates in phase with the current; *i. e.*, when the current is at zero the flux is at zero. In Fig. 102 the flux is represented by curves of arrows.

Owing to the variation of this flux linkage through the coil B_1, an E. M. F. will be induced in B_1. We assume that this E. M. F. can



Figs. 102 and 103.—Mutual Induction Between Coils.

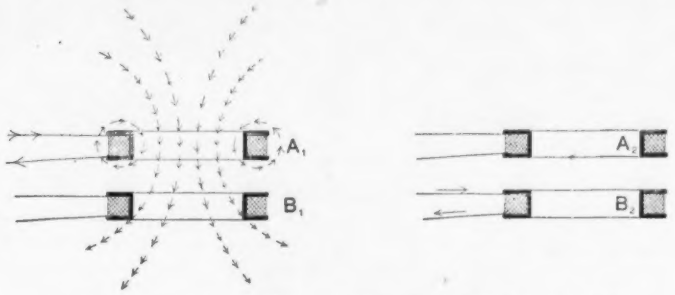
send no current around B_1, because B_1 is open circuited. The E. M. F. so induced will be in C. G. S. units, the rate of change of the linkage in weber-turns-per-second, taken negatively. The rate of change of φ, at any moment, represented by the symbol $\frac{d\varphi}{dt}$, is known to be $I\, L^u\, \omega \cos \omega\, t \times 10^8 = I\, L^u\, \omega \sin\left(\omega\, t + \frac{\pi}{2}\right) \times 10^8$, and the E. M. F. in volts is $-I\, L^u\, \omega \sin\left(\omega\, t + \frac{\pi}{2}\right) = I\, L^u\, \omega \sin\left(\omega\, t - \frac{\pi}{2}\right)$.

The induced E. M. F. in B_1 is a sinusoid of amplitude $I\, L^u\, \omega$ volts and is retarded $\frac{\pi}{2}$ radians, or 90° behind the current, or the magnetic flux. The coil A_1, which is excited by the alternating current, is called the *primary coil*, and the coil B_1, which is subjected to the flux linkage thereby produced, is called the *secondary coil*. The E. M. F. induced in B_1 is called the *impressed secondary* E. M. F., because this is the E. M. F. to which the secondary coil is subjected by the variation of flux linkage.

55. Fig. 102 represents the condition existing between the coils A B, which are wound right-handedly, when a wave of current is at its maximum in A_1. At this instant there will be no E. M. F. induced in B_1. Fig. 103 shows the corresponding condition at the next quarter cycle when the current in A_2 is at zero and the E. M. F. in B_2 is at a maximum in the direction indicated by the arrows; *i. e.*, the direction of the current which has just ceased to exist in the coil A_2. At the next quarter cycle, represented in Fig. 104, the current and magnetic flux in A_3 are a maximum, while the E. M. F. induced in B_3 is zero. At the next quarter cycle, represented in Fig. 105, the current and flux are again zero in A_4, while the E. M. F.

is a maximum in B_4, and oppositely directed to that in Fig. 103; or, in the same relative direction as the current which has just ceased to exist in A_4.

156. These conditions are also represented for the particular case in Fig. 106, where the primary current steadily established in A is shown by the unbroken sinusoid. The induced E. M. F. in B is represented by the broken or dotted sinusoid, which is retarded



FIGS. 104 AND 105.—MUTUAL INDUCTION BETWEEN COILS.

90°, or 0.002 second, behind the primary current. The moments corresponding to Figs. 102 to 105, are represented at A_1, A_2, A_3, A_4, respectively. The amplitude of the primary current is 5.656 amperes, representing an effective current strength of $\frac{5.656}{\sqrt{2}} = 4$ amperes (Sec. 53). The frequency is represented as 125 cycles per second, corresponding to an angular velocity of $125 \times 2\pi = 785.4$ radians per second. Assuming that the mutual inductance between the coils

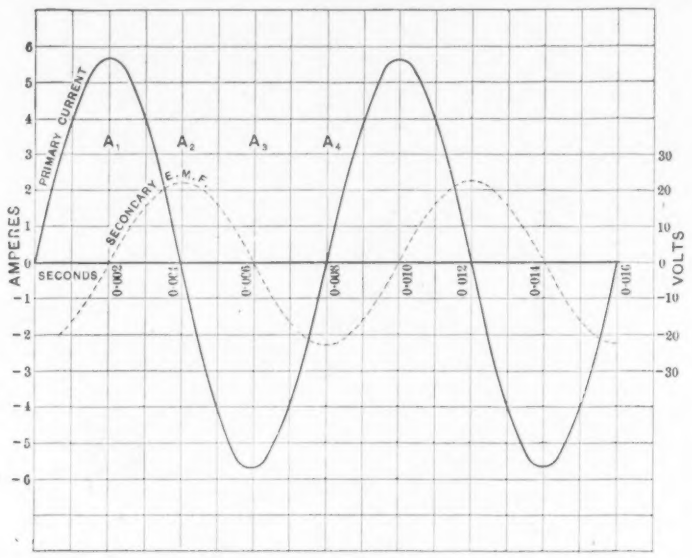


FIG. 106.—DIAGRAM SHOWING RELATION BETWEEN THE PRIMARY CURRENT AND IMPRESSED SECONDARY E. M. F. IN FIG. 102.

is 5 milli-henrys or 0.005 henry, the induced E. M. F. is $5.656 \times 0.005 \times 785.4 \sin\left(785.4\, t - \frac{\pi}{2}\right) = 22.5 \sin\left(785.4\, t - \frac{\pi}{2}\right)$ volts = 15.71 volts effective. It will be seen by comparison with Fig. 54, that the induced E. M. F. in the secondary coil coincides in phase with the self-induced E. M. F. in the primary, and this must always be the case, because the same movement of magnetic flux produces both.

157. A current of i effective amperes in the primary circuit therefore produces in the secondary circuit an impressed effective E. M. F. of $-j\, i\, L_u\, \omega$ volts; *i. e.*, an effective E. M. F. of $i\, L_u\, \omega$ volts retarded 90° relatively to i.

158. We have seen that the quantity $j\, l\, \omega$, which is the product of self-inductance l, and angular velocity of alternation, rotated through 90°, is called the reactance, and is capable of being expressed in ohms. Similarly the quantity $j\, L_u\, \omega$, which is the product of a mutual inductance and the angular velocity of alternation, may be called the *interactance*, and may also be expressed in ohms. The product, taken negatively, of a current strength in amperes and the reactance it encounters, in ohms, gives the reactive E. M. F. in volts, or the E. M. F. of self-induction in the circuit. Similarly the product taken negatively of a primary current strength in amperes and the interactance in ohms gives the E. M. F. in volts induced in the secondary.

Fig. 107 is a vector diagram indicating the above relations in the particular case represented in Fig. 106. Here the vector $O\, X_u$ is the interactance, $j\, L_u\, \omega$ 3.93 units in length, and have an angle of 90°. The primary current is $o'\, I'$ of 4 units length and at standard phase; while the product, taken negatively, of $x\ \omega_u$ and i, or $-j\, L_u\, \omega$ is

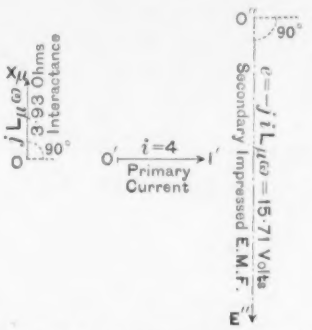


FIG. 107.—VECTOR DIAGRAM, SHOWING INTERACTANCE AND SECONDARY INDUCED E. M. F.

represented by $o''\, E''$ 15.71 units in length and 90° behind $o'\, I'$ in phase. This is the impressed secondary E. M. F.

159. There are but few arrangements of two coils or windings which enable the mutual inductance and interactance to be readily determined. One of these arrangements has been already described in Sec. 153, but there are two others which deserve notice.

If a straight helix or solenoid, whose length is great compared with its diameter, be closely and uniformly wound, as diagrammatically represented in Fig. 108, with n turns per centimeter of length, over a core or cylinder of wood or other non-magnetic material, its mutual inductance with a superposed coil of N, turns of any diameter, small by comparison with the length of the solenoid, is approximately

$$L_u = 4\,\pi\, n\, S\, N \text{ centimeters or } \frac{4\,\pi\, n\, S\, N}{1{,}000{,}000{,}000} \text{ henrys,}$$

where S is the cross-section of the core or interior of the solenoid, in square centimeters.

160. Again, if an anchor-ring or tore of wood, as represented in Fig. 109, be uniformly and closely wound with a closed circular helix, and the diameter of a section through the core, the mutual inductance

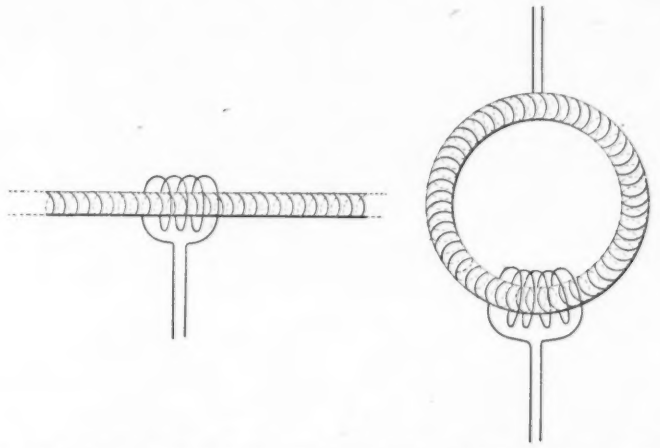


FIG 108.—DIAGRAMMATIC SKETCH OF A LONG SOLENOID WITH FOUR SUPERPOSED SECONDARY TURNS.

FIG. 109.—DIAGRAMMATIC SKETCH OF CLOSED CIRCULAR OR TOROIDAL COIL, WITH FIVE SUPERPOSED SECONDARY TURNS.

between the closed circular solenoid and a superposed coil of N, turns linked with the ring and of any diamenter is approximately

$$L_u = 4\pi\, n\, S\, N \text{ centimeters; or, } 4\,\pi\, n\, S\, N \times 10^{-9} \text{ henrys,}$$

where n is the number of turns per centimeter of mean circumference, N the number of superposed and linked secondary turns, and S the cross-sectional area of the core.

Thus, if there are 3000 turns on the ring, and its mean circumference is 100 cms., the turns per linear centimeter, $n = 30$. If the internal cross-section $S = 10$ sq. cms. (corresponding to a section diameter of 3.57 cms.) a superposed coil of $N = 50$ turns will have a mutual inductance with the ring coil of approximately

$4\,\pi \times 30 \times 10 \times 50 \times 10^{-9}$ henrys $= 6\,\pi \times 10^{-5} = 0.0001885$ henry, or 0.1885 millihenrys.

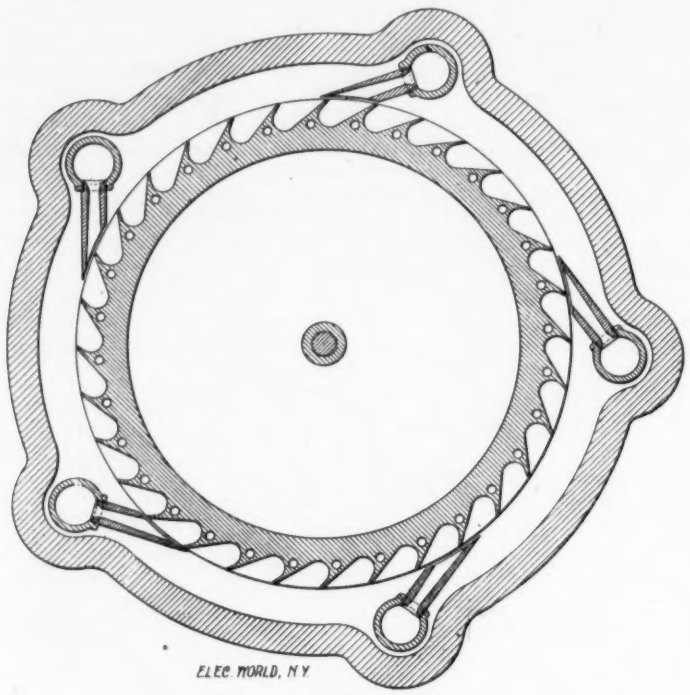
If an alternating current of angular velocity $\omega = 377$ radians per second be passed through the ring coil, (corresponding to a frequency of 60~), the interactance between the ring-coil and the superposed secondary will be $j\ 377 \times 0.0001885 = j\ 0.07106$ ohm, and a primary current of 10 amperes effective will induce in the secondary coil an impressed E. M. F. of $-j\ 10 \times 0.07106 = -j\ 0.7106$ volts effective.

The mutual inductance and interactance have simple expressions in the above cases owing to the fact that there is no magnetic leakage in the primary windings and consequently all the magnetic flux which passes through the turns of the primary coil also passes through each turn of the secondary.

Some Phenomena of High Speed Rotation.*

BY JAMES F. M'ELROY.

The phenomena referred to in this paper are those connected with high-speed rotation as we have observed them while engaged in the development of a steam turbine running at very high speeds. As a steam turbine is a device in which rotation is produced by a high-pressure jet of steam, which reacts on vanes or pockets of an impact wheel, its essential principles of action are similar to those of a water turbine. Differences of structure are, however, made necessary by differences in the specific gravity and velocity of the moving fluid. In both the steam and the water turbine the greatest efficiency is obtained when the motion of the bucket receiving the impact of the moving fluid is one-half the velocity of the fluid itself. This follows

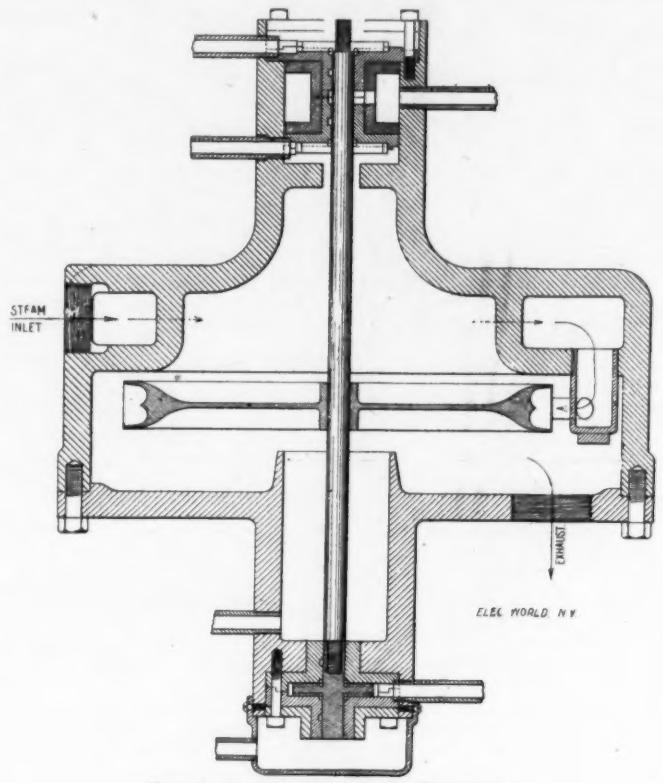


Sectional Plan of Turbine.

from the fact that if a moving jet of fluid rebounds from a surface the rebounding jet has a velocity exactly equal to that of the incident jet. It is plain that if the motion of the bucket is one-half that of the incident jet, the latter will strike the wheel with a relative velocity equal to the absolute velocity of the wheel and rebound with the same relative velocity, that is without motion relative to the case, its energy being wholly transferred to the wheel. As water has a high specific gravity its moving velocity is low, and it is very easy to construct a water turbine to realize the maximum efficiency. With a steam turbine, however, the conditions are very different. The weight of the moving fluid is small, and its velocity is so very great that the greatest care is required in the design and construction of the steam turbine in order that the velocity of rotation of the moving vanes may even approximate one-half of the velocity of the steam. The velocity of steam discharged in a jet ranges from 1400 to 2600 feet per second. In order to reach the maximum efficiency, a peripheral velocity of from 700 to 1300 feet per second must, therefore, be obtained. Consider for a moment what such a velocity means. A speed of 1300 feet per second is about that of a rifle ball in the common practice of twenty years ago. On account of the high velocity and the internal strains produced by it, it is necessary that the wheel be made as light as possible, and of the best material, and be designed so as to preserve the greatest possible strength in its structure. In spite of this, such speeds are likely to create such enormous tension stresses as to break the wheel into pieces or produce stretching and distortion. The breaking of such a wheel results in a violent explosion, the pieces being thrown in different directions with about the same velocities as though they were fired from a cannon.

The apparatus represented in the drawings consists of a cast-iron casing, in which a vertical shaft is placed, carrying a turbine wheel with divided buckets.

Above this wheel is a steam passage formed between the tur-



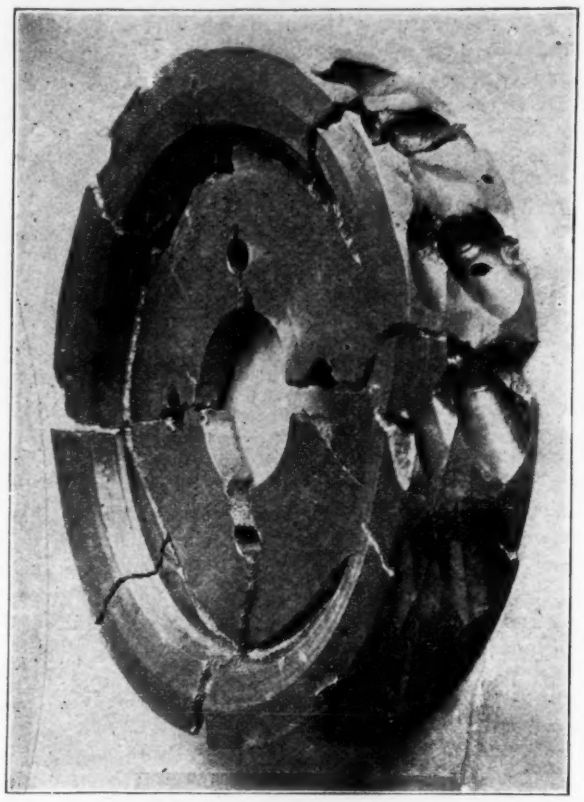
Sectional Elevation of Turbine.

bine casing and an inner ring. Suitable connections are made for the steam to flow from this circular passageway through five jets, which direct it tangentially into the pockets of the rotating wheel. One of our first experiments was made with the web of one side of the wheel. The wheel itself was made of phosphor-bronze and carefully machined to produce as nearly as possible a perfect balance. The wheel was run at a velocity of about 20,000 revolutions per minute. After this run it was found that the centrifugal force had dished the disc of the wheel and allowed the peripheral flange to expand, the circumference being very materially increased. The stretching of the metal was uniform, and as perfect as though it had been turned to shape on a lathe. Taking advantage of this experience, we made another wheel with the web placed centrally in the ring, thus doing away with a large overhang of metal on the upper side of the wheel. With this wheel there was no tendency to dishing, but in experimenting with it one day the wheel suddenly went to pieces. The explosion did not burst the turbine casing, although it broke the bolts employed to bind the balance ring in place. The illustration shows the pieces of this wheel which are brought together and arranged in something like their original positions. From this it will be seen that the ring carrying the pockets was broken entirely free from the central web or disc. There were indications that the outer ring went to pieces first, and that the web revolved around its centre against obstructions, after which it broke.

In the construction of apparatus for high-speed rotation, a peculiar difficulty is met with in the vibration of the turbine shaft, which is set up entirely apart from its rotation proper. The vibration occurs at fixed intervals, separated by several thousand revolutions, and occurs whenever certain rates of speed are reached, whether by increasing from a lower or decreasing from a higher speed. This secondary vibration is generally attributed to imperfect construction of the

* Abstract of a paper read before the Albany Institute, Feb. 2, 1897.

wheel or its mounting on the shaft. It is claimed that the centre of gravity does not correspond with the centre of the shaft itself, which would cause the shaft to rotate in an eccentric manner, and thus produce a side vibration. From what I have seen of this secondary vibration I do not believe that this explanation explains the phenomena. If it did, the vibration of the shaft would occur at all high speeds, whereas, as a matter of fact, the vibration only occurs at certain speeds, and the wheel runs silently and smoothly at intermediate speeds. I have repeatedly observed that the turbine wheel will revolve smoothly so long as its speed is kept within the limit of about 3500 revolutions per minute, but when an attempt is made to force its speed above this rate, the wheel begins to vibrate and springs the shaft from ¼ to ½ inch, when the wheel is likely to strike the turbine casing with considerable force. After passing the critical speed the turbine wheel will at once settle down and run quietly until its speed is very nearly doubled, when it will again begin to vibrate, and difficulty will be found in forcing it to higher speed. On reducing the speed the same agitation takes place at the same critical points,

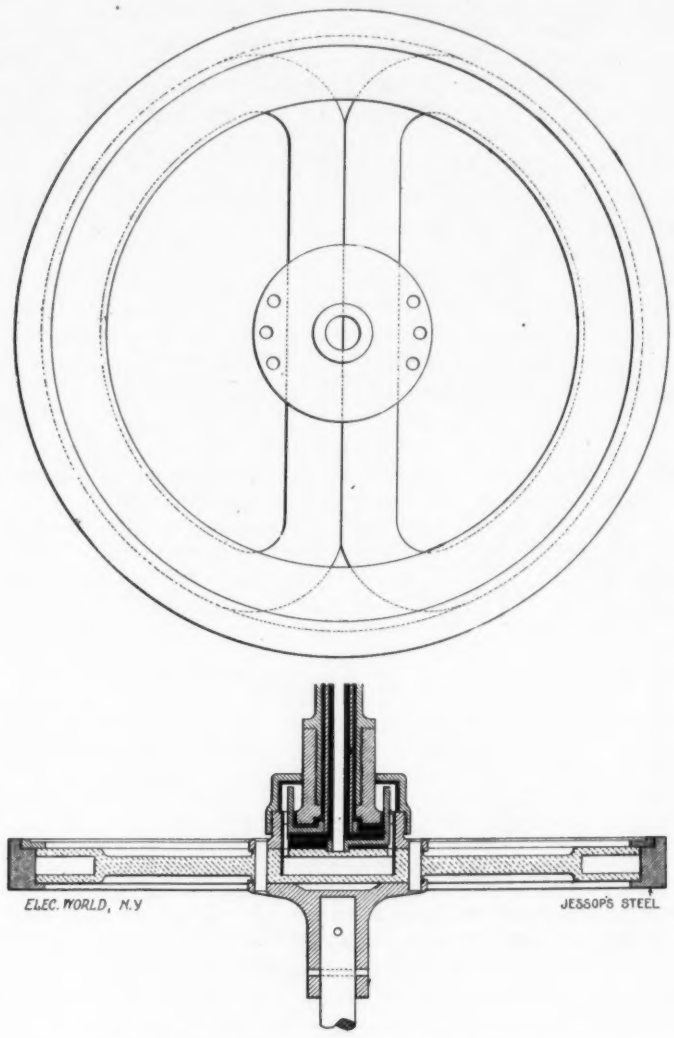


TURBINE WHEEL AFTER EXPLOSION.

I was surprised to find that when the shaft was vibrating violently the vibrations could be very much reduced and the shaft forced out of its critical period by gently pressing against it with a piece of wood. We afterwards tried the expedient of placing a composition ring in a cushioned support around the shaft, an opening through the ring being made so that the shaft would not touch, except when it began to vibrate. In this way the violence of the vibrations was very largely overcome.

In the course of experiment on high-speed rotation, we constructed a dynamo, whose armature was connected directly to the high-speed turbine shaft. The armature was intended to run at a velocity of from 8000 to 10,000 revolutions per minute. The armature consisted of a disc of insulating material, containing two D-shaped coils made up of insulated strips of copper. The straight bar of the *D* extended diametrically across the centre of the disc, and the curved part completed the circuit around the semi-periphery. Magnetic fields of opposite polarity were placed on opposite sides of the disc, and the magnetic circuit completed by the lines of force passing up through one-half of the disc and down through the opposite half, so that by the rotation of these two loops, an alternating current was generated within them. This was taken off by brushes resting on a small collector on the armature shaft. A strong steel ring enclosed the insulating disc and the copper coils, so as to enable the armature to withstand the strains due to centrifugal force. The diameter of this armature was 12¾ inches, and about 100 lights were supplied with current from the armature at a speed of 9000 revolutions per minute. The whole turbine and dynamo could have been placed in a cylinder 14 inches in diameter and 3½ feet high. One of these armatures was constructed with a disc of celluloid, and when run at full speed a peculiar phenomenon was developed. The celluloid was disintegrated through its whole mass where exposed to the magnetic lines of force and only where exposed to such lines. This was evidently not due to the heating of the ribbons of copper, as the celluloid in contact with them was not in any way changed. It appears to me that it was a case of disintegration due to the rapid cutting of the lines of force by the celluloid itself. Greater success was had with these discs by using wood as an insulating medium.

The use of ball bearings in a steam turbine is hardly permissible. I have found it impossible to make, without case-hardening, a sur-



ARMATURE DISC SHOWING "DOUBLE D" SHAPED COILS.

face in the ball bearing, in which the balls will not spin a groove in the solid steel. In one of our early experiments, we constructed a thrust-bearing, which carried a weight of about 3½ pounds. The shaft extended through a hole in this bearing, and the line of steel balls traveled around in a circle half an inch outside the hole. Notwithstanding the fact that the bearing was made of a solid piece of machine steel, the line of balls spun a path in the metal and spread the solid steel so that it reduced the size of the opening until all the free space around the shaft was taken up, binding the shaft and bringing it to a standstill. From our observations of these experiments I am inclined to believe that a mass of steel of considerable size may be worked by a rolling tool if acted upon with sufficiently high velocity. We adopted afterward a thrust plate, a circular disc of steel in which were cut small curved grooves from centre to circumference. Stationary upper and lower bearing plates were placed at opposite sides of the disc and helical grooves were cut in the journal bearings, so that oil could reach the centre of the disc. The whole bearing was placed in the bottom of a cast-iron pot in the turbine casing, which was filled with oil. There would, of course, be a tendency to throw oil radially from the centre to the circumference of the grooves in the steel disc. We found that this little centrifugal pump had suf-

ficient power not only to supply the bearing with oil, but to raise a head of oil 22 feet high in a solid column.

Allow me to say, in closing, that while the steam turbine presents new phenomena, as well as old phenomena many times intensified, I believe that the objectionable phenomena of the steam turbine have been largely removed. I have great faith in the future of the steam turbine, as it furnishes a source of power more simple, and mechanically quite as efficient, as the ordinary reciprocating engine of the same power. I have, in these remarks, dwelt more upon the phenomena of high-speed rotation, as they have appeared while in the course of development of a high-speed turbine, than upon the construction and operation of the completed turbine, in which the difficulties here referred to have been largely overcome.

Programme of the Street Railway Convention.

The following is the programme of the sixteenth annual meeting of the American Street Railway Association, to be held at Niagara Falls, N. Y., on Tuesday, Wednesday, Thursday and Friday of next week:

TUESDAY.

10 A. M., meeting called to order by Robert McCulloch, president; address of welcome by Hon. A. C. Hastings, mayor; calling of the roll; address of the president; report of the executive committee; report of the secretary and treasurer. Reading of a paper on "Municipal Ownership of Street Railways," by P. F. Sullivan, general manager, Lowell and Suburban Railway Company, Lowell, Mass. Reading of a paper on "Some of the Difficulties Existing in the Construction and Operation of Electric Street Railways," by G. W. Knox, electrical engineer, Chicago City Railway Company, Chicago, Ill. Entertainment—At 2:30 P. M. a visit will be made to the power house of the Niagara Falls Hydraulic Power & Manufacturing Company, after which the cars of the N. F. & S. B. Railway Company will convey the party to the power house of the Niagara Falls Power Company, and the factories of the Niagara Falls Paper Company and the Carborundum Company. Entertainments will be provided in the evening at the hotels, music, dancing, etc., and if weather is pleasant, trolley parties, excursions to visit the Rapids, etc.

WEDNESDAY.

The convention will convene at 9:30 A. M. The order of business will be: Reading of a paper on "Application of the Storage Battery to Electric Traction," by Charles Hewett, electrical engineer Union Traction Company, Philadelphia, Pa. Reading of a paper on "Power Distribution and Use of Multiphase Current Transmission for Ordinary Street Railways," by Maurice Hoopes, electrical engineer, Lynn & Boston R. R. Company, Lynn, Mass. Appointment of committee on nomination of officers and next place of meeting. At 2:30 P. M. the party will walk across the upper Suspension Bridge to the Canadian side, where the cars of the Niagara Falls Park & River R. R. will convey it to Chippewa and Queenston; there the steam ferry of the Niagara Falls Navigation Company will be taken to Lewiston, thence by the cars of the Niagara Falls & Lewiston R. R. Company (Great Gorge route), through the Gorge to Niagara Falls. The committee will provide entertainments in the evening.

THURSDAY.

The convention was called to order at 9:30 A. M. Reading of a paper on "Discipline of Employees," by George H. Davis, superintendent Canal & Claiborne R. R. Company, New Orleans, La. Reading of paper on "Application of Electricity to Railroads Now Operated by Steam Power," by H. N. Heft, president Meriden Street Railway Company, Meriden, Conn. Reading of a paper on "Best Methods of Settling Damage Cases and Prevention of Accidents by Use of Fenders or Otherwise," by C. G. Goodrich, vice-president and general manager Twin City Rapid Transit Company, Minneapolis, Minn. Election of officers. A trip will be arranged for the ladies to Youngstown and Fort Niagara over the Great Gorge route and the Frontier Railroad at 9:30 A. M., in charge of the ladies reception committee, assisted by gentlemen of the reception committee. At 7 P. M. the annual dinner will take place at the International Hotel.

On Friday a short session will be held, beginning at 9:30 A. M., for the completion of unfinished business, installation of officers and adjournment.

The Duty on Electric Light Carbons.

An interesting phase of the question of duty on electric-light carbons has recently developed as a result of the vague phraseology employed in the section of the Dingley tariff bill relating to this subject. When the bill was under consideration in the Senate, Mr. Quay called attention to the matter, with the object of having the meaning of the provision made more specific. The rate fixed was 90 cents a hundred, there being no limitation of size. The Senator suggested that under this loose construction dealers could increase the length of the carbons, and, after importation, cut them into proper lengths for use, thus escaping the payment of a large proportion of the duty that should properly be collected. He was not successful, however, in securing the change desired. It is stated now that carbons are being imported in lengths of 32 inches, from which three of commercial size can be made; and the importers are insisting that they are subject to a duty of 90 cents a hundred only on the extended lengths.

The Treasury Department was notified of this state of affairs, and a conference has been held on the subject between Appraiser Wakeman and the Treasury authorities, but no formal action has been announced as the result of this meeting. It is stated, however, that the appraiser will construe the law to mean carbons as used in electric lighting and extended lengths will be assessed for duty on that basis.

The Longest Trolley Ride in the World.

It is possible, according to the Boston *Herald*, to make a continuous trip of 124 miles over electric railway lines in actual operation in the Eastern States. The route given is as follows: From the residence of Mr. Henry H. Rogers, at Fort Phoenix, in Fairhaven, to Nashua, N. H., through New Bedford, Fall River, Taunton, Bridgewater, Brockton, Braintree, Quincy, to Boston, and then through Malden, Melrose, Wakefield, Reading, Wilmington, Bellerica, Lowell, Dracut, to Nashua. The only break in this line is from Bowensville, a part of Fall River, over Slade's Ferry bridge, a distance of about 1 mile. This connection is made by means of a coach, which meets every car, free transfers being given. The tracks are now being laid, and it will be but a short time before the entire distance will be connected by rail.

Memorial to Galileo Ferraris.

On the death of Galileo Ferraris there arose a general desire to honor his memory by means of a monument in the city of Turin. The Italian Electro-Technical Association took the matter in hand, and undertook the collection of a subscription fund. A large foreign committee was appointed, composed of the prominent electricians the world over. Blanks of the subscription list have arrived in this country and are being circulated. Anyone who desires such blanks, and wishes to subscribe, may obtain further information at the offices of The Electrical World. Among the American members of the committee are the following: Dr. Frederick Bedell, Charles S. Bradley, Coleman Sellers, Dr. Louis Duncan, H. Hering, John W. Lieb, Jr., Prof. Henry Rowland, Charles P. Steinmetz, Nikola Tesla, Prof. Elihu Thomson, Joseph Wetzler and Edward Weston.

Electric Lighting in London.

The central station of the Hammersmith Vestry (London) has just been formally inaugurated, together with an electrical exhibition in the Town Hall. The system adopted is a high pressure alternate-current distribution, with transformer sub-stations, the rectified current being used for the public arcs. The alternating-current is supplied by Messrs. Ferranti, the cables by Messrs. Callender and the arc lamps by Messrs. Siemens Bros. The Dublin electricity-supply undertaking, which has since its inception in 1892, been anything but a marked success, will shortly come up for discussion before the Town Council, as it is proposed to spend no less than £100,000 in extensions.

DIGEST OF CURRENT TECHNICAL ELECTRICAL ARTICLES COMPILED FROM FOREIGN AND AMERICAN JOURNALS

BY

CARL HERING

LIGHTS AND LIGHTING.

The Electric Arc. HESKETH. Lond. *Elec.*, Sept. 24.—An article in which he deduces the practical efficiencies gained by certain modifications, such as smaller carbons and longer arcs, basing his arguments on the results of tests which he made. He believes that a great range of possibilities lying latent in the arc have been left undiscovered and that the arc lamp of to-day is in almost the same elementary state and undeveloped originality as it was ninety years ago; there is a demand for small current arc lamps, using less than 5 amperes, and of these very few are used; the various ways of increasing the efficiencies of the arc are therefore of importance, because, unless the efficiency is better than that of large incandescent lamps, the latter would be used in preference. His discussion and experiments deal only with the direct-current lamp After allowing a loss of 60 per cent. in the diffusion, the light from a nominal 2000 cp-lamp is only about 500, and the useful light will therefore be obtained at an efficiency of about one candle power per watt, which is still far in advance of the incandescent lamp. He then determined the value of the light gained by reducing the diameter of the negative carbon by means of carefully verified photometric tests with lamps similar in all respects except the size of this carbon; while the results show the desirability of making this change, yet the increased efficiency is not of practical utility for all purposes; the curves for both are given, and while the gain is great the change is decidedly disadvantageous for public street lighting; the curves of illumination on a plane at right angles to the rays are given, and at 15 feet from the base the illuminations from a 12 mm and a 7.5 mm carbon, are 1.1 and 1.5 candle-feet respectively; the latter, while considerably greater, is objectionable, as it makes a detrimental comparison with the darker parts, anything above 0.2 candle foot being too great a contrast, as it is glaring; when the lamps are to light up an area immediately around their base, the advantage of the smaller carbon is apparent. He then discusses the effect of increasing the length of arc; a curve shows that the fifty-five volts which Carhart found gave a maximum efficiency, may be exceeded; a formula is given for the mean hemispherical candle-power as a function of the voltage between 35 and 58; in using high voltages, the positive carbon is consumed to a more acute point; the increase of light after a certain voltage is past may be found in the varying forms of that part of the carbon undergoing volatilization; the present abnormal cross-section of carbon is productive of the greatest of all its inefficiencies; the harder the carbon and the more homogeneous, the higher the heat necessary to vaporize it and the efficiency is a function of this temperature; the crater should be kept as flat as is consistent with the maintenance of the arc, and this is one of the reasons why the air-tight type of lamp has a higher efficiency; another very important point is to diminish the heat lost by conduction; it is unanimously agreed by different experimenters that there is a decided gain in this direction produced by reducing the size of the carbons; the mean hemispherical candle-power per watt may be increased 150 to 200 per cent. by using smaller carbons; this modification is, however, beyond our reach until some new form of arc has been placed on the market, which will allow longer and thinner carbons to be used; he makes an estimate showing that, compared with the enormous increase in illuminating power, the greater cost of trimming and of the thinner carbons are negligible; he urges central stations to adopt the improvements.

Enclosed Arc Lamp.—Elek. Anz., Sept. 9.—An illustrated description of the Koerting and Mathiesen lamp, which is said to have the advantage over others of giving a greater light output, partly because the outer globe has a very small diameter and partly because there is a large reflector above the lamp; a pair of carbons will burn 150 to 200 hours.

Incandescent Lights in a Fog.—La Nature.—A note stating that a fog in London diminishes the brightness of an ordinary gas flame 11.1 per cent., while that of an incandescent lamp is diminished 20.8 per cent.; Lewes explains this by saying that the incandescent lamp is rich in violet and ultra-violet rays, and these are the ones that are absorbed most by a fog.

Temperature Variations in Incandescent Lamps. JANET. *Zeit. f. Beleucht.*, Sept. 10.—A German translation of a large portion of the mathematical article which was noticed in the *Digest*, June 26.

Train Lighting in France. SARTIAUX. *L'Eclairage Elec.*, Sept. 25.—An abstract with illustrations, of an article describing the accumulator system used by the Northern Railroad of France.

Arc Lamps and Their Mechanism. WATTS. *Elec. Eng.*, Oct. 7.—A continuation of his article (see *Digest*, last week). He discusses the sliding contact, the magnets, shunt versus differential lamps, and carbons.

POWER.

Gas Engines in Central Stations. KOERTING. *Zeit. f. Beleucht.*, Sept. 10.—A reply to a recent article in the *Elec. Eng.* (N. Y.), May 26, which he claims is likely to give wrong impressions concerning the gas engine of to-day; in the present article he defends the gas engine, referring to its construction in Germany; conclusions regarding the gas engine arrived at in England and other countries, he claims, do not apply to those made in Germany, where the results are claimed to have been very satisfactory.

Floating Current Motors.—Elek. Anz., Sept. 26.—A short article supplemental to the one noticed in the *Digest*, Aug. 28, describing motors used in streams.

District Distribution of Energy. EMERY. *Eng. Mag.*, Oct.—An article comparing briefly the various systems, with special reference to the steam system He believes that each is useful under proper conditions in a particular location, and in the article he endeavors to ascertain these conditions for all the methods, with special reference to steam; he gives due credit to electricity, which he says has come to stay, but claims that it cannot in all locations displace other means.

Water Works Pumping Plants.—Eng. News, Oct. 7.—A note stating that the commissioner of public works at Chicago proposes to utilize the boiler batteries of the pumping plants to supply steam to the electric-light plants at night, when there is less demand for water; where the existing electric-light plants are not near enough to be supplied with steam, the engines and dynamos are to be moved to the pumping station.

Electric Power in a Large Railway Shop.—Cassier's Mag., Oct.—A short, profusely illustrated interview with Webb, the chief mechanical engineer of the London & Northwestern Railway, describing the very successful use of electric power in the large shops at Crewe, in which 20,000 men are employed. Electric power has been especially successful when applied to portable drills; these shops also construct their own electrical machinery.

Electric Plows.—Eng. Mag., Oct.—A brief abstract from *Die Elektrizitaet*, July 17 and 31, in which there is described what is claimed to be the latest form of apparatus. A gang plow is hauled back and forth across the field, the electric motor being carried on the plow itself and drawing by means of a chain anchored at each end, the current being supplied through a pair of trolley wires, which can be moved laterally across the field as the work progresses. An advantage over steam is that the engine driving the dynamo may be placed near a convenient water supply, thus avoiding the necessity of carrying the feed water.

TRACTION.

Electric Towage on Canals.—Lond. *Engineering*, Sept 24 and Oct. 1.—A continuation of the article noticed in the *Digest*, Sept. 18. An illustrated description of the Bovet system is given; in this the chain for haulage passes over a grooved pulley which is so magnetized that the chain closes the magnetic circuit, thus enabling this driving pulley to obtain the necessary friction around three-quarters of its circumference; the data regarding the friction are given. This system was described in the *Digest* some years ago, and has been in successful use on one of the French canals.

Electric Haulage on Canals. MIRON. *L'Ind. Elec.*, Sept. 25.—An article giving an illustrated description of the same system which was described in another article noticed in the *Digest*, Oct. 2.

Mileage of Electric Railways.—Lond. *Elec. Eng.*, Oct. 1.—Brief statistics given by Walcknaer. In Germany there are 400 miles, France 175, England 82, Switzerland 50, and 10 to 20 miles each in Belgium and Spain, making a total in Europe of 940 miles, on which 300 cars are used; the mileage in America is given as 12,500.

Orbe and Chavornay Railway. PRELLER. Lond. *Engineering*, Oct. 1.—A fully illustrated description of this short railway in Switzerland, which is said to be of interest, as it is a typical light railway worked by electricity.

Dover.—Lond. *Elec. Rev.*, Oct. 1.—An illustrated description of the electric railway system which was recently started; the overhead trolley system is used.

Douglas.—Lond. *Elec. Eng.*, Oct. 1.—A reprint of the general conclusions of a very lengthy report on the proposed electric traction and lighting of this city; the overhead trolley system is the one recommended.

Modification of Electric Railways for Three-Phase Currents.—Elek. Anz., Sept. 12.—An illustrated description of the Lachmann system, which may be applied to underground or overhead trolley conductors to adapt them to the use of three-phase currents. There are in all cases three conductors and three collectors or trolleys; the conductors are crossed at regular intervals so as to change their relative position, the method of crossing being somewhat similar to that used in telegraphy and telephony; each trolley or contact shoe makes contact with one of the sections; for underground work it appears that the crossings may be sufficiently frequent to have a car cover three of them, but for overhead work the illustration shows a train of five cars, in which only the first, middle and last have trolley poles. As the car moves forward the magnetic field revolves in a forward direction and in the same direction as the revolution of the motor; there is therefore a movable field which is revolved by the motion of the car; it is claimed that there is no sparking in passing from one conductor to the other; it is also claimed that the change can easily be made in existing overhead and conduit lines.

Application of Electric Power on Trunk Line Railways. Forbes. *Eng. Mag.*, Oct.—A long article intended "to give those who are financially interested in railways the results of disinterested and careful study and extensive calculation." He describes briefly the experience on several American and English lines which should be grouped with steam railroads as distinguished from street railways; this includes the operating costs of the City and South London, the Liverpool, and the London Metropolitan District (steam) Railway, and shows the remarkable economy in operating the Liverpool line. There would be nothing experimental in constructing trunk lines operated electrically, and the estimates of cost can be made out with the greatest accuracy, but they are not included in the present article; he considers it indisputable that the feeders may be supplied with currents at 10,000 volts or more, either continuous or alternating, and then transformed down to a continuous current for the trolley wire; he has prepared designs for a transformer and commutator machine (not described) which is free from the defects of others, namely that they are expensive, cumbrous, and require continual attention, and he says it can be manufactured at a small cost. After a laborious study of the whole question his opinion is that as a rule electric locomotives with power developed by steam would be cheaper than the steam railroad up to a distance of 40 and 50 miles from the power station; with water power it would be cheaper on a busy line for several hundred miles; he takes the cost of coal as $1.50 per ton; although the method of working is ideal, it can be applied to trunk lines only when constructed totally independently of existing steam railroads; on a large scale with trunk railroads locomotives must be used, and the advantages of the electric system using locomotives are not nearly so great as when the power is applied to every axle of the train. While in the examples given, electric traction is able to compete with steam, yet the advantages are not sufficient to overcome the natural conservatism against changing existing methods; special consideration should be given to suburban traffic; the question of a slight difference of cost one way or the other is of far less importance than that of independent trains at a shorter headway. A number of the advantages and disadvantages are pointed out, which are already understood. Besides the above conclusions, he gives the following: In an independent system of railways to be constructed in a new country unaffected by the traffic in steam railroads, power can be applied to every axle, and it will then be economical in construction and operation to use electricity; for desert railways where water is not obtainable, electric traction is eminently suitable; in underground railways where economy is not as important as convenience and comfort, electricity must be used, and where such railways are to be constructed economy makes electricity advisable; for suburban traffic electricity helps to overcome the competition of street railways on account of the ability to use separate independent cars at frequent intervals.

Possibilities of Rapid Electric Travel. Davis and Williamson. *Eng. Mag.*, Oct.—The first part of a long illustrated article in which they outline a plan for a rapid-transit electric line between New York and Philadelphia, in order to show by means of a specific case the possibility of doing what is supposed by many to be impossible. This line will bring Philadelphia within thirty-six minutes of New York harbor; the length will be about 85 miles, and the average speed 141 2-3 miles per hour, or 2.36 miles per minute, or, allowing six minutes to start and the same to stop the train, the full speed would be 170.05 miles per hour, or 249.4 feet per second; the proposed car, an illustration of which is given, would weigh about 150 tons loaded; at a resistance of 4 pounds per ton the car would require 272 horse-power for full speed; the ruling grade would be 0.20 per cent.; a profile and plan of the line is given; the third rail system is to be used; the system of signals is discussed. Their conclusion is that such a road would be an engineering possibility without departing so radically from present practice as to make the chances of success less than those of failure; the project is claimed to be no bolder than that of the Suez Canal or the Brooklyn Bridge. The next article will treat of the probable cost, the operating expenses and the receipts.

Compressed Air for Elevated and Street Railways.—Eng. News, Oct. 7.—Reprints of several reports and statements, in some of which comparisons are made between compressed air and electric traction. The first is a tatement by Haupt, which is in favor of the system used by his company; referring to the recent tests on the Manhattan Railway he claims that "the test demonstrated a most gratifying success for the system itself, but indicated the necessity of some slight (*sic*) changes in the details"; he gives the history of the Hardie motor from 1881 to date, and makes some comparative estimates of cost, including estimates of the first cost for equipping a road in Washington with compressed air and conduit electric system, showing the cost of the former to be very much less (a comparison of the operating costs, however, is not given). The second is a report by Emack to the District of Columbia commissioners, on the compressed air system proposed for a line in Washington; it describes the plans and gives the estimated costs of two compressed air and three electric systems, showing the former to be much less; but the cost of operation, including interest, is also given and is less for the underground electric systems. The next is a report by Black, to the same commissioners, on the compressed air system; he also gives the first cost and total operating expenses for both, the former being higher and the latter lower, for the electric underground than for the air system; in conclusion he states that the air motor system possesses many good qualities, but is yet experimental, which latter forbids its installation on so large a scale; the system may be what is claimed for it, but satisfactory evidence has not yet been presented. The last is a report by Macfarland to the same commissioners, being a report on the compressed air cars in use in New York City. There is also a long editorial article discussing this subject; the statement by Haupt that the data is sufficient to indicate a decided economy for compressed air is not agreed to; some data for the Popp system in Paris are given, and they are compared with those recently given by Gerry on the electric line in Chicago; the best that can be said in favor of the fuel economy of the compressed air system is that it is equal to that of the electric system used in Chicago; the preference would then depend on other conditions than fuel economy; the relative advantages and disadvantages of the two systems are discussed; adhesion without great weight on the drivers is more easily obtained in the electric system of motor cars; for elevated railways the third-rail system would be used which is much cheaper than the conduit system for which the estimates above referred to were made.

Power Consumption of Electric Railway Cars.—Jour. of El'ty, Aug.—Brief replies from a number of railway lines (apparently all on or near the Pacific Coast, giving the starting horse-power, that on grades and that on a level at full speed, beside the name of the line, the name of the maker of the truck, and of the motors. No general conclusions are drawn.

Street-Railway Engineering. Cahn. *Elec. Eng.*, Oct. 7.—The first part of an article in which brief descriptions are promised; the present one refers to the small station in Zurich, in which a stationary plant of 245 ampere hours is used, enabling the dynamos to run constantly at full load; there is a saving thereby of 450 tons of coal annually, while the cost of maintenance of the cells is only one-tenth of that of the coal saved. (More complete descriptions of this installation have been referred to in the *Digest*.)

Union Loop in Chicago.—West. Elec., Oct. 9.—A short description of this electrically operated addition to the elevated railroads of Chicago; a map of the roads is included.

Power Station of the Metropolitan Company, New York.—Elec. Eng., Oct. 7.—An illustrated description of this new power house, where 70,000 horse-power is to be generated.

Rack Railways. Corthell. *Eng. Mag.*, October.—An illustrated article on the Abt system of mountain railways; twenty-nine such roads have been built by Abt. The last part is devoted to a description, with some new illustrations, of the Jungfrau road, which is under construction, and which is to be operated electrically.

Motor Road Vehicles. Sachs. *Jour. Frank. Inst.*, October.—The conclusion of his long illustrated paper, which refers only briefly to electric carriages; it is chiefly a description of the various mechanisms used.

Electric Launches.—Elec. Eng., Oct. 7.—A brief illustrated description of some of the launches, of which there are now forty-four in service, a complete list of which is given.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Free Supply of Incandescent Lamps.—Lond. *Lightning*, Sept. 23 and 30.—Comments of various central-station managers and engineers on the recent paper of Gibbings, which was abstracted in the *Digest*, Oct. 2.—Bax believed it much better to let consumers buy their own lamps where they want to; a central station which gives away lamps, and therefore secures a customer in a district, would assume a very heavy responsibility and make enemies in the trade; the storing and distribution of such a large number of lamps would entail much extra work. Patchell stated that the system was merely a discount on the consumer's bill, and he thinks a reduction in the shape of a cash discount would be equally beneficial; it involves a capital outlay for extra meters where arc lights and motors are used. Blackman objected to the words "free lamps," as they are not really free; the system is unfair to consumers using arc lamps or motors; a large number of additional meters would have to be bought and kept in repair; he does not think there is a valid claim for the system. Sutherland considered the supplying of the lamps as a sort of a bribe. Watson, the only one in favor of the system, says it has much to recommend it; the reduction amounts to about 7 per cent., but it is distinctly unfair to

the users of arc lamps and other consuming devices; he suggests as a fairer method to give a discount of 5 per cent. for prompt payment, the discount being allowed if preferred, or a certain number of lamps which are tested and guaranteed supplied instead. Bain thought that a sliding scale of discounts would meet the case better; a small consumer using the light during long hours would get more lamps than he needed; the system would also affect manufacturers of lamps seriously. Barnard thought the advantages did not outweigh the disadvantages; he prefers the maximum demand system, which is more fair. Vesey-Brown favored the system, and suggested that arc-lamp and motor consumers might be given a discount eqnal to the cost of a lamp for every 60 units used per year.

Centralization of the Supply of Electricity. WRIGHT. Lond. *Elec. Rev.*, Sept. 24.—An article referring more particularly to the proposed combination of all electric-supply stations for light, power, railways, etc., in the city of Glasgow, and is therefore chiefly of local interest; this city is about to supply in the near future about 20,000 horse-power for traction, power and lighting. He suggests a scheme for the management and operation of such a combined plant; also the various committees, one of which is a general one and the others sub-committees, one on production, one on distribution and one on finance; he discusses the question of how payment should be made so as to be equitable; in this he urges the adoption of the maximum demand system which is known under his name; for the railway currents he recommends as the best method to put a meter in the circuit of each feeder; the curves of these readings when superposed will show the incidence of the demand, while the sum of the readings will give the consumption; this would enable an accurate adjustment of the financial relations to be established. In the issue of Oct. 1 a number of communications are published, all of which seem to endorse the suggestions of Wright; some of them make further suggestions.

Hammersmith.—Lond. *Elec. Eng.*, Oct. 1, and *Lightning*, Sept. 30.—A long illustrated description of this 400-kw alternating-current central station in which Ferranti rectifiers are used for the arc lights. The distribution is through six sub-stations.

Transformer Sub-stations and Street Boxes. STEINITZ. Lond. *Lightning*, Sept. 23.—Illustrated descriptions of the sub-stations in Leicester and the street boxes in West Ham.

Private Plant. LAFFARGUE. *L'Ind. Elec.*, Sept. 25.—An illustrated description of the private plant in the works of Milde & Co. (France) which is in effect a small central station supplying both continuous and alternating currents.

Zurich.—Elek. Zeit., Sept. 23.—Long extract from a report of the operation of this municipal station for the year 1896.

Detroit.—Elec. Eng., Oct. 7.—An extract from the report of this municipal lighting plant. There is also an editorial discussion of it, in which the argument is against municipal ownership.

Garfield Park Station in Chicago.—Power, Oct.—A brief illustrated description of this plant, which the city constructed for lighting its parks and boulevards on the West Side.

WIRES, WIRING AND CONDUITS.

Rating of Resistance Spirals. ZINGLER. Lond. *Elec. Rev.*, Oct. 1.—The conclusion of the article which was noticed in the *Digest*, last week. The present portion refers to observations with galvanized steel spirals in which three different current densities were used. The most important results are given in the tables and curves, which cannot be abstracted. With spirals wound on seven-eighths inch mandrils the charring point of paper was reached at about 300 watts per foot and for one-half inch mandrils at 200 watts. With the curves of data given, the work of designing resistance spirals is greatly simplified, although he claims that special tests should be made.

Non-Inflammable Wood. ELLIS. *Cassier's Mag.*, Oct.—An abstract of a recent paper read in London describing in a general way a new process, the results of which seem to be very successful. The timber is placed in a cylinder where a vacuum is formed and into this steam is admitted causing the moisture to be vaporized, the products being drawn off; a vacuum is again formed and a saturated liquid containing certain salts (not named) is forced in as a fine spray mixed with steam until the wood is thoroughly impregnated, after which it is dried and is then ready for use. The salts retard the rapid carbonization of the wood and particularly the generation of combustible gases which are the cause of flame. To test this wood, two buildings were constructed and set on fire, one with treated and one with untreated wood; the latter was completely consumed, while the former remained intact, the wood being merely charred where it came in contact with the flames of the oil used to start the fire. It is also claimed that the process has a valuable conservative action against dry rot, insects, etc.

Rules of the N. Y. Fire Department.—Elec. Eng., Oct. 7.—An editorial discussion of some of these new rules.

ELECTRO-PHYSICS AND MAGNETISM.

Lenard Rays. DES COUDRES. *Wied. Ann.*, No. 9, noticed briefly, with two illustrations, in the Lond. *Elec.*, Oct. 1.—A description of a novel apparatus for generating Lenard rays by means of a simple, cheap apparatus. The tubes are made of ebonite with a brass screw cap for the anode, containing the aluminum window and a tube leading to the pump; the tubes are about the size of a finger. An apparatus for generating oscillations of great amplitude and high frequency is also shown; a Leyden jar is discharged through a zinc gap in series with the primary of an induction coil. With this apparatus he succeeded in proving that cathode rays behaved outside of the generating tube exactly as in the inside; they have the same coloring effects on salts and generate Röntgen rays when they impinge on other surfaces; they also impart a discharging power to gases traversed by them.

Photographing Fluoroscopic Images. PORCHER. *L'Ind. Elec.*, Sept. 25.—A reprint of an Academy note describing experiments which show that there is nothing gained either in time or sharpness by photographing the image formed on the screen.

Maximum Voltage of an Induction Coil. OBERBECK. *Wied. Ann.*, No. 9; abstracted briefly in the Lond. *Elec.*, Oct. 1.—Instead of characterizing an induction coil by the length of the sparks, it would be better to give the maximum voltage, and he attempts to solve this problem. He attached a needle point to one terminal and gradually approached a charged spherical conductor to it, the potential of which is known; the potential of the needle point at any distance is then easily calculated; the distance at which the first permanent deflection of an electrometer connected with the needle point takes place is called the critical distance. Measurements thus made showed that for a given apparatus and interrupter the transformer ratio is very nearly constant.

Discharge Inside of a Metallic Cage. EBERT and WIEDEMANN. *Wied. Ann.*, No. 9, abstracted briefly in the Lond. *Elec.*, Oct. 1.—They show that a metallic case does not protect the gas inside against electric discharges under all circumstances. The phenomena which they observed are said to be another proof that low-pressure gases are often better conductors than the metals themselves.

Condenser Discharge. GARBASSO. *L'Eclairage Elec.*, Sept. 25; abstracted briefly from *Nuovo Cimento*, July.—A theoretical article showing how the discharge of a condenser is affected by giving the discharge two paths; he also shows how the phenomena may be represented mechanically.

Rotating Magnetic Field. COLARD. *L'Eclairage Elec.*, Sept. 25.—A continuation of his mathematical discussion (see *Digest*, Sept. 25), in which he assumes the number of phases to be infinite. He reaches the following conclusions: that the field remains constant in magnitude at all points in space; that the direction of the field in every other point revolves with a uniform angular velocity and with an efficiency equal to that of the alternating currents; that this rotation in the interior is in the same direction as that "of the plane of the zeros of current" and in the external part in the reverse direction. The field is therefore truly a revolving field, its intensity is constant in all points of space and it revolves with a constant velocity.

Magnetization by Oscillatory Discharge. VEILLON. *Proc. Lond. Phys. Soc.*, Sept., noticed briefly from a French journal.—He describes experiments with needles or bars magnetized by Leyden jar discharges, the permanent magnetization being afterwards determined by eating away the successive layers from the bars by means of acid, thus enabling the distribution of magnetism in the interior to be studied. It was shown that this magnetization, instead of decreasing regularly toward the interior, like when produced by a continuous current, undergoes numerous oscillations; the variation depends upon the nature of the discharge; it is probable that the effects superpose themselves successively and attain depths depending upon the dimensions of the bar and on the hysteresis; the total magnetization is composed of coaxial layers with alternately opposite polarity.

Magnetization of a Ring. SAUTER. *Wied. Ann.*, No. 9, noticed in the Lond. *Elec.*, Oct. 1.—He investigated the distribution of the magnetic flux in a partially wound ring excited by various currents; his formula for the dispersion is reproduced; it appears that the article is mathematical in character.

Magnetic Screening. ERSKINE. *Wied. Ann.*, No. 9, abstracted briefly in the Lond. *Elec.*, Oct. 1.—He used a magnetized glass-hard needle as a means for testing rapid electric oscillations; with these he measured the screening action of metallic cylinders against the influence of a rapidly varying magnetic field produced by Leyden jar discharges. The screening action is almost annulled by slitting the metallic covering lengthwise; the action also increases with the diameter and with the thickness of the tinfoil tube.

Viscous Magnetic Hysteresis. KLEMENCIC. *Wied. Ann.*, No. 9, abstracted briefly in the Lond. *Elec.*, Oct. 1.—He investigated the exact course of the magnetic after-effect from the instant of magnetization, as also its dependence on the dimensions of the rod and the field intensity; he used a combination of the ballistic and the magneto-metric methods. He found that the magnetic after-effect appears almost exclusively in weak fields; it decreases as the field grows, especially if the rod is thin; it cannot be eliminated by strong magnetization; it is a temporary property.

Magnetic Properties of Soft Steel with Long-Continued Currents. ABT. *Elek. Zeit.*, Sept. 23; abstracted briefly from a German journal.—He compared the properties of Martin steel with carefully annealed soft iron, when both were subjected to the action of a long-continued current; under

these circumstances they found that the differences between soft steel and iron are very slight, and that soft steel may therefore be used for powerful electromagnets; the permanent magnetism of the soft steel is not much greater than that of the iron.

Calculation of Electromagnetic Attraction. Vogelsang. *L'Ind. Elec.*, Sept. 25.—An abstract containing the mathematical deductions of the article noticed in the *Digest*, Sept. 18 (see also Oct. 5).

Franklin's Kite Experiment. McAdie. *Pop. Science Mo.*, Oct.—An interesting illustrated description of repetitions of Franklin's experiment carried out with more modern appliances. Franklin's original description of his experiment is reproduced. The present writer made numerous experiments extending over a number of years; in the earlier ones he discovered that showery or thunder storm weather were not the only conditions giving marked electrical effects; large deflections and sparks could be obtained at other times; sparks were even obtained when the sky was cloudless; it could be seen positively from the electrometer needle whether the kite was rising or falling, as the voltage would go up or down accordingly, showing that the electric potential increases with the elevation; a snow storm was almost identical with a thunder storm in its tremendous electrical changes; some of the experiments were made from the top of the Washington Monument, and during severe thunder storms potentials as high as 3000 or 4000 volts were obtained just before the lightning; mechanical means were used to obtain continuous records of the potential. In one experiment he succeeded in going through a storm with the kite flying; a fusilade of sparks could be drawn from the kite wire; at one time the electrometer flared up brilliantly; a 105-volt incandescent lamp placed in circuit showed some light but no incandescence of the filament, the light coming more from the glass surface; in the later experiments the more modern forms of kites were used with better success. He suggests using a transformer with a circuit breaker in the circuit of the outer coil in order to obtain lower voltages and greater currents; it may not be profitable commercially, but it might lead to interesting results.

Compass Variation Affected by Geological Structures. Lyman. *Jour. Frank. Inst.*, Oct.—A reprint of a short paper, including a map, in which he shows an interesting coincidence between a geological fault and a very decided variation in the compass.

The Electromagnetic Properties of Heat Rays. Rubens and Nichols. *Phys. Rev.*, Sept.—The conclusion of the article which was noticed in the *Digest*, Oct. 9; it consists largely of descriptions of their researches; no general conclusions are drawn.

Arc Spectra. Foley. *Phys. Rev.*, Sept.—A very long article describing his recent researches; photographic reproductions of a number of the spectra are given. These researches are no doubt the same as those described in his recent paper, which was noticed in the *Digest*, Sept. 25.

Conversion of Electrical Energy in Dielectrics. Threlfall. *Phys. Rev.*, August.—The conclusion of his long article describing his very extended researches. Among his conclusions he states that the effect of moisture is far from being eliminated by the Arno method, but a steady state may be produced by prolonged drying and a residual hysteresis effect then makes its appearance; this hysteresis is quite constant for any given specimen, but very variable in different specimens; it is nearly futile to treat the specific inductive electric capacity of a substance as distinguished from a specimen, as being constant; a drag on a spheroid exerted by the rotating field implies either that dielectric polarization takes an appreciable time to become established, or that it does not die away in simple proportion to the force produced.

ELECTRO-CHEMISTRY AND BATTERIES.

Separating Metals with Electric Meters. Danneel. *Zeit. f. Elektrochemie*, Sept. 20.—An article describing attempts to analyze alloys by separating the metals by electrolytic decomposition, with some form of meter in circuit. In his researches he used an ingenious form of mercury voltameter, in which the cathode is freely suspended from the arms of a balance, so that the mercury deposited may be weighed while in the liquid. The advantages of using mercury are its high atomic weight, the nature of the deposit and the purity; a correction in the use of this instrument becomes necessary on account of the specific gravity of the solution in which the mercury is weighed; the apparatus can be used for only small current densities, but for these it is very convenient. The conclusions of his experiments are that the analysis of the metals by this method is not satisfactory, as they do not deposit in equivalent quantities, the reason being that the electrolysis of the water takes place with voltages above 1.08, when the concentration of the metaloids in the solution approaches that of the hydrogen.

Depositing Nickel from its Sulphate or Chloride. Foerster. *Zeit. f. Elektrochemie*, Sept. 20.—The first part of an article in which he discusses the electrolytic deposition of nickel from these aqueous solutions; he does so because the methods used commercially in the metallurgy of nickel are kept secret; he gives the results of his own experience. Among other things he shows that the peeling off and the brittleness of the nickel may be avoided and a tough, polished deposit of any desired thickness obtained, if the electrolyte is heated to 50-90°, and this applies equally well to the sulphate as to the chloride; it is easier to transfer the nickel in a sulphate solution than in the chloride; it appears that both cobalt and iron are also deposited with the nickel and the nickel must therefore be purified afterward; relatively large amounts of cobalt and iron, however, do not interfere with the deposition of the nickel; more difficulties are encountered in the electrolysis of the chloride; more extended researches are to be made with nickel and with anodes of peroxide of lead; cobalt will also be included.

Electrolytic Separation of Nickel and Cobalt from Iron. Ducru. *L'Ind. Elec.*, Sept. 25.—An Academy note describing a method which can be applied to the analysis of nickel in steels. Great difficulties are encountered in separating nickel and cobalt from large quantities of iron, and of all the methods proposed none have been satisfactory. The present method is claimed to be rapid and accurate; the solution of the iron and nickel is precipitated by ammonia in excess; a large proportion of the nickel will be held by the ferric hydrate, but when subjected to electrolysis all the nickel will be deposited; almost always a small quantity of iron will also be deposited with it, but this can be reduced to about a quarter of a per cent. of the amount of iron present; in very accurate analyses a correction must therefore be made, which can be done by dissolving in hydrochloride acid, and after peroxidation precipitating it by ammonia. In the analysis of nickel steel traces of manganese also appeared on the cathode; he describes how the necessary correction may be made; it appears that even a very small quantity of chromic acid interferes with the deposition of the nickel.

Chlorates. Hurter process. *L'Eclairage Elec.*, Sept. 25.—A brief description of this process of making alkaline chlorates. The diaphragm is made of a series of fine layers, consisting of a mixture of Portland cement, salt and water; after drying, the salt is dissolved out; this diaphragm is not affected by the electrolyte; the anode is platinum; there are a number of cells through which the electrolyte circulates, from one to the other; it is operated at 60° to 80° C.; the description is very incomplete.

Mutual Diffusion of Electrolytes. Behn. *Wied. Ann.*, No. 9, abstracted briefly in the Lond. *Elec.*, Oct. 1.—He attempted to verify Nernst's mechanical theory of liquid diffusion, by the quantities of ions passing across the surface of contact when two solutions are brought together. The results do not agree well with the theory, but distinct evidence was obtained of diffusion against the concentration gradient in cases where the electrostatic attraction surpassed the osmatic pressure as forseen by the theory.

Alkalies and Alkaline Chlorates. Bayet. *L'Elec.*, Sept. 25.—An abstract of a recent paper, which gives a general description of a method, but appears to contain nothing new. A translation in part is published in the Lond. *Elec. Eng.*, Oct. 1.

Electrolyzed Sea Water for the Purification of Sewerage. Hewett. Lond. *Elec. Rev.*, Oct. 1.—A reprint of a recent report on an experimental installation at Bombay, the results of which so far have been unfavorable. The plant has been at work for over thirty days; comparative estimates of the cost of this and other methods are given, and they are not favorable to the electrolytic process; it is thought, however, to be too soon to make any strict comparisons; the plant will be worked continuously until the end of the year, after which a reliable basis of comparison will be obtained.

Electrolytic Conductivity of Diluted Gases. Wiedemann and Schmidt. *Elek. Zeit.*, Sept. 23, abstracted briefly from a German journal.—It has often been claimed that the conductivity of flames and gases is an electrolytic one; they therefore conducted experiments to test the correctness of this assumption; their experiments gave them negative results; they found that at the electrodes there is in many cases no product of decomposition, and wherever there is a deposit the quantity of it does not follow Faraday's law.

Nitrogurets. Pauli. Lond. *Elec.*, Oct. 1.—A translation in part of the article which was noticed in the *Digest*, October 2.

Calcium Carbide Factory Near Geneva.—Zeit. f. Elektrochemie, Sept. 5.—A long abstract of the descriptive article which was noticed in the *Digest*, June 5.

Electricity Direct from Carbon.—Zeit. f. Elektrochemie, Sept. 20.—The conclusion of the article noticed in the *Digest*, Oct. 2; descriptions are given of the Bernstein method, taken from his English patent of 1885, in which it appears that hydrogen and carbonic acid gas are used; also of the Blanchard method, as described in his American patent of 1882; a lead accumulator is used, and is kept charged with oxygen and hydrogen; also of the method of Westphal, as described in his German patent of 1880; the carbon is converted into its gases, which are then used with oxygen in a gas battery; illustrated descriptions of the apparatus are given in each case.

Effect of Pressure on the E. M. F. of Cells. Claude. *L'Ind. Elec.*, Sept. 25.—He discusses the subject of pressure with special reference to the researches of Cailletet and Colardeau, which were noticed in the *Digest*, three years ago. Some calculations made for a pressure of 600 atmospheres showed a gain in E. M. F. of only 10 per cent; it therefore appears to be of no use to resort to pressure unless other results than the increase of E. M. F. is desired. It is a special case of the general rule that mechanical storage of energy is always much inferior to storage by chemical means.

Storage Batteries. Wade. Lond. *Elec.*, Sept. 24.—The beginning of

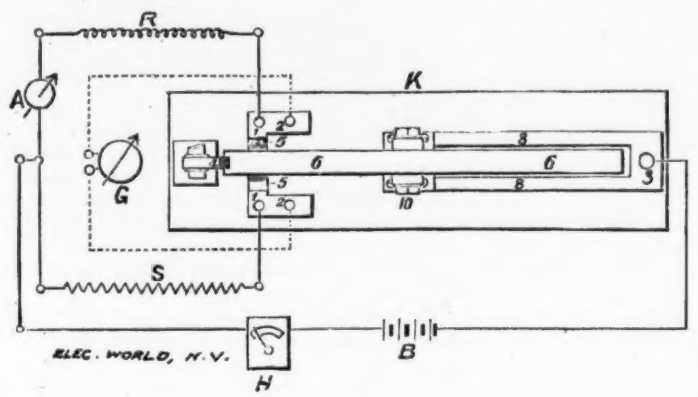
what promises to be a long serial, which is to be published in book form. The present portion is introductory in character; it is on nomenclature, calculation of electrodes and material of the supports, but contains nothing new.

Accumulator Construction. FITZ-GERALD. Lond. *Elec. Eng.*, Oct. 1.—A short article deducing simple formulas for calculating the dimensions of cells and plates (without regard to their capacity).

Filter Diaphragms. HULIN system. *Elec. Eng.*, Oct. 7.—An illustrated description of the system referred to several times before in the *Digest*, in which the numerous difficulties in electrolysis are claimed to have been overcome by making the electrodes of porous material, which form the two opposite sides of the retaining cell; the products of decomposition on their inner surface then filter directly through the electrodes, and are thereby removed. The process is used to produce caustic potash from sulphate of potash, and for other like decompositions.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Method of Measuring the Coefficient of Self-Induction. FRY. Lond. *Elec. Rev.*, Sept. 24.—A brief description of an exceedingly simple method due to Thiermann and which has been used with good results; very few and simple instruments are all that are required. Referring to the adjoining cut, R is the conductor whose self-induction is to be measured; S is a

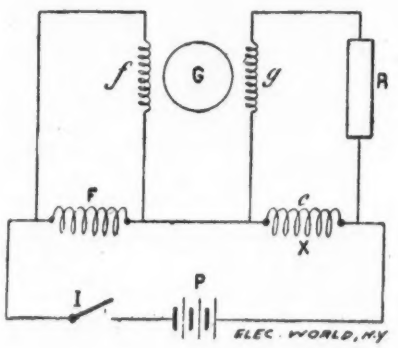


conductor having approximately the same resistance; G is a ballistic galvanometer; A an amperemeter; H an adjustable rheostat and K a special key; in this key, 6 is a lever held by trigger 4, which when released opens the circuit between 5 and 5 and also between those plugs and the lever; it is very important that this lever breaks contact with both of those plugs at the same instant. To make the measurement, the circuit is closed and an appropriate current is passed through R, which current must be measured; the galvanometer being short-circuited will show no deflection; as the trigger is released the induced current due to self-induction will pass through the galvanometer, as can be seen by following out the connections; the coefficient of self-induction X is then calculated from the following equation:

$$X = \frac{c}{C}(r + s + g)$$

n which c is the induced current in amperes which varies rom C to zero; C is the main current in amperes before opening the key; r, s and g are the resistances in ohms respectively of the conductors R, S and the galvanometer.

Measuring Low Resistance. SANTARELLI. *L'Eclairage Elec.*, Sept. 25;



abstracted from *L'Elettricista*, May.—The method is very simple and has given very accurate results, which are independent of the polarization of the battery to be used. Referring to the accompanying illustration, G is a differential galvanometer, f and g represent its coils; F is a convenient resistance, c a known resistance and R a resistance box; the rest of the figure explains itself. The value of the resistance R is changed until there is no deflection in the galvanometer when the key is closed or opened; the resistance c is then replaced by the one to be measured and the resistance R is changed until no deflection is produced in the galvanometer when the circuit is closed; the unknown resistance is then calculated from the following formula:

$$X = \frac{c(r+g)}{R+g}$$

in which R is the first adjustment of that resistance and r the second (presumably g is the resistance of the galvanometer.)

Measuring Capacity with a Balance. LANG. *Elek. Zeit.*, Sept. 23, abstracted from an Austrian mathematical journal.—When great accuracy is not required the balance method may be used; on one arm of a balance is suspended a horizontal wire spiral, the ends of which are connected with a condenser; below the spiral is a smaller but stationary one, through which an alternating current is sent, and it will then induce a current in the suspended spiral, the phase of which will be in advance; the two coils will attract each other, and the attraction may be measured by the balance; when the capacity of the condenser connected to that coil is not more than a few microforads, then the attraction will be represented by the expression

$$P\,C\,(1 + a\,C)$$

in which P is a constant and a a certain theoretically defined quantity depending on the period and the self-induction coefficient; these two quantities can first be determined by using two condensers of known capacity; presumably the formula represents the attraction in milligrams, although it is not so stated in the abstract.

Magnetic Units. BRYLINSKY. *L'Eclairage Elec.*, Sept. 18.—The first part of a mathematical article discussing the magnetic units with special reference to the magnetic inductive power; he complains that much confusion has been introduced in the literature on the theory of magnetism, by the complete suppression of this factor and by introducing instead, in certain phenomena, the factor called magnetic permeability. It seems from certain quotations that some authorities appear to consider that induction and field intensity are two distinct quantities which can be expressed by means of the same units only in the electromagnetic system; this he claims has led to serious confusion, for which Maxwell is largely responsible. He shows that the factor usually represented by K is not a numerical constant, but a quantity having dimensions and characteristic of the medium in which the magnetic action is propagated; it is called the magnetic specific inductive power, or more briefly the magnetic inductive power. The article appears to be concluded in the issue of Sept. 25. He claims that in any system to be used in practice it is very necessary to fix, by some arbitrary hypothesis, the nature and value of that factor K in vacuum for instance; the two hypotheses which are ordinarily made, and both of which are inexact, consist in making K equal to the reciprocal of the square of the velocity of light and this forms the electrostatic system; or K is made equal to unity, which then gives the electro-magnetic system; the latter is the only one which he considers. He gives the dimensions of a number of the quantities and considers it indispensable, as suggested by the American Institute of Electrical Engineers, Lodge, Hospitalier and Blondel, to name the principal magnetic units; the American system is given and discussed; he considers the names gauss and weber as well chosen, but objects to oersted as not sounding well and to gilbert as undeserved; he prefers instead the kelvin and maxel for the reluctance and the M. M. F. respectively. The next question is the value to be given these units, and he gives decided preference to a practical system like that for the ampere volt, etc.; he recommends making the maxel equal to 10^{-9} units; the kelvin 10^{-1} units; the gauss as equal to a kelvin by a quadrant, that is, 10^{-10}; the weber equal to a gauss by a quadrant squared, that is, 10^{-8}; the unit magnetic pole would be equal to $4\,\eta$ webers. In practice the megamaxel would be used for large reluctance, and the kilomaxel for swollen ones, the kelvin would correspond to the usual reluctance and the quantity would be represented in kelvins by the number of ampere turns divided by $4\,\eta$; the weber would correspond to the flux in modern machines; the number of revolutions per second multiplied by the number of windings in series in the armature and by the flux in webers would then give the E. M. F. of the dynamo in volts. This system is therefore a very appropriate one, except with reference to the gauss, and for this he suggests using the prefix "super," representing 10^{12}, that is, the square of the power represented by the prefix mega; the supergauss would then be used as the megohm or microfarad, and would be a more convenient unit. He shows how these units could be conveniently applied in practice; the number of webers divided by the surface in square decimeters would give the induction in supergausses; the permeabilities and reluctances in maxels; the product of these by the flux gives the M. M. F. in kelvins, and the quotient of these by $4\,\eta$ gives the ampere turns; thus the calculations would be very simple.

Instrument for Measuring Frequency. MEYER. *Zeit. fuer Elek.*, Sept. 15.—A long article in which he describes the new form of his instrument, the principle of which is that a stretched wire moves a reflecting prism by means of which the changes in its length can be measured with a telescope and scale. This wire passes through the centre of the solenoid through

which the current whose frequency is to be measured is passed, the wire stretching on account of the heat generated in it due to hysteresis and Foucault currents. The difficulty lies in the calibration for high frequencies, for which any deductions from calculations are unreliable; these he discusses and describes several methods for the empirical calibration; one of these is to use a high-frequency alternator like the one of Tesla, whose frequency is 30,000 per second, or of Ewing, 56,000, or of Pyke and Harris, 64,000. Another method was described by Kittler, in which the frequency is measured acoustically by the note which is produced in an electromagnet. He describes Dobrowolsky's frequency indicator, which consists merely of a rotating disc in a field containing two perpendicular coils, the rotation being opposed by springs; also another apparatus devised by the same inventor in which there is an electromagnet with an air gap, the sides of which are not parallel but approach each other; in this air space is placed the edge of a revolving disc of copper, which will then tend to rotate against the action of the opposing spring.

Voltmeter for Examining Successive Cells of a Battery of Accumulators.—*L'Elec.*, Sept. 25.—An illustrated description of the one mentioned in the *Digest*, Aug. 28.

Arons Amalgam Arc Lamp for Spectroscopic Purposes.—Zeit. f. Beleucht., Sept. 20.—An illustrated description of the lamp and results obtained with it by Gumlich, who carried out the suggestions of Arons to use a cadmium amalgam in this vacuum lamp, which was described in the *Digest*, some years ago; the cadmium spectrum lines fill out the gap in the spectrum of the bright mercury lines in the spectrum of Arons' mercury lamp. The chief difficulty encountered is the removal of the layer of oxide which is formed; a form of the lamp which gave satisfactory results is described and illustrated and the results are given. The brightest cadmium line was still inferior to the brightest mercury line; the lines shown by the Arons mercury lamp, especially the green one, represent the brightest monochromatic light which can be generated; lines were also obtained with the zinc amalgam which were not greatly inferior to those obtained with cadmium.

Accuracy of Thomson Wattmeters. Sessions. *Jour. of El'ty*, Aug.—The first of an article in which he intends to discuss the points to be improved upon in electric meters. After discussing the construction of the present one, he calls attention to the influence of the surroundings; strong magnetic fields or heavily loaded feeders will make it run faster or slower, or even backward, when no current is used; the permanent steel magnets may lose their strength, making the meter run faster; or particles may collect on the magnets, making it run slower; the high resistance coil in series with the armature causes very much trouble; sections of it become short circuited, making the meter run faster; it is impossible to balance the friction of meters where there is vibration, as the balance force remains the same, while the friction, in that case, is continually changing. In view of these facts those who use the meters should inspect them, and consumers would do well to have their meters tested independently.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Wireless Telegraphy.—L'Ind. Elec., Sept. 25.—A short account of the experiments at Spezzia. It seems that the results obtained were not in general as good as those previously noticed. One of the spheres was connected with the sea and the other to a zinc plate about a hundred feet above the ground; under the best conditions the signals were received at a distance of 16 km, but they were affected by atmospheric conditions, so much so that sometimes the limit of perception was less than half this distance; one of the most important results was that the transmission is greatly affected by obstacles in the direction of the transmission; while the vessel was passing behind a point of land the signals ceased completely, but were again received as soon as the vessel was again in sight from the sending station; it seems, however, that satisfactory transmission can be obtained at a distance of 3.5 km, the receiver being placed in the hold of the vessel 2 5 meters below the surface of the water line.

Telegraphy without Wires. Dowsett. Lond. *Elec. Eng.*, Oct. 1.—A brief illustrated description of a recent demonstration by Marconi in England; there appears to be nothing new in it. On being asked whether he thought telegraphy without wires would replace the ordinary telegraph, he gave it as his belief that such would not be the case; the new system would be used where wires were not possible, as for railway signals, for ships, in war, etc. He came to the conclusion that the wave traveled along the ground.

Cable to Iceland.—Lond. *Elec.*, Oct. 1.—A note stating that according to an authority there is no present likelihood of this cable being constructed; regarding the suggestion that such a line would be the first link of a cable to America via Greenland and Labrador, it is stated that there is no probability of such a connection being made. The Lond. *Elec. Eng.*, Oct. 1, notices a favorable description of this proposed cable from the London *Times*.

Working of Long Submarine Cables. Sayers and Grant. Lond. *Elec.*, Oct. 1.—A reprint of the profusely illustrated students' paper which was noticed in the *Digest*, July 24 and August 7.

Typical Telephone Exchange. Wright. Lond. *Elec. Eng.*, Oct. 1—The beginning of an article describing the construction and working of a typical small exchange of the National Telephone Company's system (the one operating the telephones in London).

Telephone System of the United Kingdom. Raphael. Lond. *Elec.*, Oct. 1.—In this installment of his long serial, he gives a large number of load curves of the Metropolitan exchanges; also tables of data and illustrations of switchboards.

Telephony. Hess. *L'Eclairage Elec.*, Sept. 25.—Descriptions of some of the recent progress. It includes portions of West's recent paper read before the German society; some of the improvements of the Western Electric Co.; the Hill system and the Moore transmitter.

Telephone Statistics.—Lond. *Elec. Eng*, Oct. 1.—Some brief statistics for France, Germany and Switzerland.

Storage Batteries for Fire and Police Telegraphs. Aydon. *Teleg. Age*, Oct. 1.—A reprint of a short paper giving a general description of the plant in Wilmington, Del., where the storage battery has been used during the past fifteen months with greater success than was expected; the cost of operation is said to be greatly below that of the gravity battery which it replaced.

Telephone in the Life-Saving Service. Bolton. *Elec. Rev.*, Oct. 6.—A short communication describing the system used by the United States Life Saving Department, the author being the superintendent of that branch of the service. The total mileage of these lines is nearly 1000 and there are nearly 200 telephone connections; the service has been of great value.

Telephony.—Elec. Eng'ing, Oct. 1.—A number of short articles and paragraphs on the general subject of the patent protection of telephones (this journal is favorable to the Bell interests).

MISCELLANEOUS.

Efficiency of Ozonizers and the Quantitative Analysis of Ozone. Andreoli. *L'Eclairage Elec.*, Sept. 11.—A short article in which he calls attention to the great difference between an apparatus which will generate ozone for a short time and one which will operate continuously; it is very unjust to compare the two, as the laboratory apparatus frequently described in journals would fail if operated continuously. He discusses the various methods of determining the quantity of ozone, and shows what incorrect figures, and therefore incorrect efficiencies, may be obtained by such analyses; the analysis is so delicate and difficult that in eight cases out of ten the result will be incorrect; figures are given showing the widely different results obtained with the iodide of potassium method, depending merely on the acidity of the solution; he seems to have little faith in any of the usual methods for the quantitative determination, and states that the only way to obtain a correct opinion of the efficiency of an ozone generator is to determine the amount of the oxidation produced while cool, in 50 to 100 kg of some substance, such as linseed oil; the best ozonizer is the one which will oxidize a definite quantity of oil in the least time and with the least expenditure of energy. Running commercially, without developing heat and without water circulation, the efficiency of his ozone generator at present is not less than 100 gr per hp hour.

Electrodes for High Frequency Currents. Oudin. *L'Elec.*, Sept. 25.—An illustrated description of an electrode which he has used with success with high frequency currents, and which has given very good results for local applications, for which purposes the usual electrodes are not satisfactory, because painful sparks are apt to occur. The present electrode consists of a carbon rod placed in a glass tube with a handle of ebonite; there is, therefore, no direct contact, the action being that of a condenser, the glass tube being the dielectric; in another form a wire is contained in a thick glass tube, which is surrounded by another tube filled with oil and hermetically sealed.

Globular Lightning.—Lond. *Elec. Rev.*, Oct.—A translation of a short article noticed in the *Digest*, Sept. 25.

Lightning Rod Connections with Gas and Water Mains.—Elek. Anz., Sept. 19.—A reprint of the regulations in the city of Berlin.

German Electrical Industry.—Lond. *Engineering*, Oct. 1.—A short article pointing out the present thriving condition of the electrical industry in that country.

Prize.—L'Ind. Elec., Sept. 25.—A note stating that the French Academy has received an endowment for an annual prize of 4000 francs to be awarded by the Academy to the one who has made a discovery or done experimental work in astronomy, physics, chemistry, metallurgy, geology or mechanics, which is thought to be worthy of the prize.

Electric Journals Published in the World.—L'Ind. Elec., Sept. 25.—A list of all the journals published in the world on Jan. 1, 1897, which are devoted exclusively to the subject of electricity; they are arranged in the order of the dates when they were first published. The total number is 58, of which 15 are published in France and 11 in the United States. (All but a few of the unimportant ones are received by the compiler of the *Digest*, besides many others not exclusively electrical, and are abstracted weekly in these columns. The list is not quite correct, as there are several omissions, while several which no longer exist are included. The order in which they are published is also incorrect in some cases.)

Welded Oil Barrels.—Eng. & Min. Jour., Oct. 2.—A note stating that the Standard Oil Company intends to use steel barrels welded electrically;

he process is the one used in England and has already been described in these columns; the arc system of welding is used.

Pacific Coast Electric Transmission Association.—Jour. of El'ty, Aug.—An editorial notice stating that the *Journal of Electricity* (San Francisco) is to be the official organ for the publication of the papers and transactions of that Association; full reprints of all those papers may therefore be looked for in that journal.

National Street Lighting Association.—Elec. Eng., Oct. 7.—A report of the proceedings of the recent meeting, with a reprint of one of the papers.

Electro-Therapeutic Association.—Elec. Eng., Oct. 7.—A brief account of the proceedings of the recent meeting.

Mayors' Convention.—Elec. Eng, Oct. 7.—A record of the proceedings, with reprints of several of the papers read.

Course of Study in Electrical Engineering. OWENS. *El'ty*, Oct. 6.—A reprint of his paper which was noticed in the *Digest*, Sept. 4.

University at Chicago. STARR. *Pop. Science Mo.*, Oct.—A long, illustrated article on the instruction in science at this university; illustrations of the buildings are given.

Municipal Ownership. WRIGHT. *Elec. Eng'ing*, Oct. 1.—An article on the injustice of indirectly taxing the people while pretending to tax corporations.

Electric Furnace. LE LIEVRE system. *West. Elec.*, Oct. 9.—A translation in part, with the illustration, of the description of the furnace referred to in the *Digest*, Aug. 28.

Book Review.

ELECTRIC RAILWAYS AND TRAMWAYS: THEIR CONSTRUCTION AND OPERATION. By Philip Dawson, C.E. New York, 1897. John Wiley & Sons, publishers; 705 pages, demi-quarto; 530 illustrations; 183 tables; heavy morocco, gilt top. Price, $12.50.

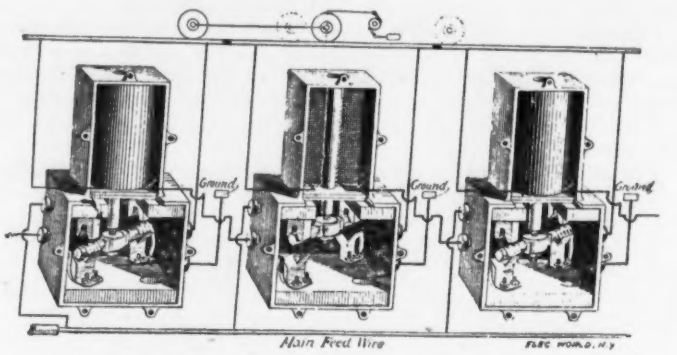
In some respects this work may be regarded as the most complete that has yet made its appearance upon the subject of electric railways. On its title page it recites the fact that it is a practical handbook, setting forth at length the modern application of electricity as a motive power for railways and tramways, and that it contains complete financial and engineering data as to design, construction, equipment and working, and fully illustrates all the modern and accepted types of machinery and apparatus used in both Europe and America, with descriptions of the more important installations. During the last two years the author of this work has been publishing in our English contemporary, *Engineering*, a series of special articles on Electric Traction, and these form, with the addition of much descriptive and statistical data, the subject matter of the book. Necessarily the greater part of the work is occupied by the description of American machinery, American installations and American methods. This country has come to be so much the home of the electric railway that a description and study of those in foreign countries only would be of no very great value. It is pleasing to see how Mr. Dawson has recognized this fact, and how thoroughly and with what detail he has enlarged upon American methods and American ideas. So much of the book is purely statistical and descriptive that there is little opportunity for criticism, but much for commendation of the excellence with which the work has been done. Perhaps the greatest value of the book to engineers will be in the very complete compendium of electric-traction methods contained in it. American engineers will find much to interest them in the full accounts of the British electric railways and the descriptions of the motor and generating systems adopted by the German and Hungarian makers. The chapter on surface-contact systems is exceedingly interesting, and describes a number of continental plants operated by this method.

Among the other features of the book that are interesting and useful is the chapter on "Specifications" for line, track, power station, motors, cars, etc.

The tables and information contained in the chapters on "Accounts and Their Classification" and the "Management of Electric Lines," are of great value, while the comparison of cost, etc., of American and European railways is exceedingly interesting. A long appendix contains a number of regulations and statutory rules referring to electric traction in Great Britain, and a reference to the authorities consulted in the preparation of the work. A complete and excellent index adds much to the usefulness of the volume. It is probable that this work will long be recognized as the standard of its kind.

A Third Rail Relay System.

In THE ELECTRICAL WORLD of June 12 there appeared an illustrated description of the Doty-Macknight-Grauten third-rail sectional railway system. Since that time the development of the system has progressed to such an extent that the apparatus of the company is greatly improved. The cars are supplied with current through a third rail laid flush with the roadbed midway between the tracks. This rail is divided into sections, short in crowded city streets, and as long as is desirable on private rights of way. The switches which connect up the sections of the third rail to the main feeder are electrically operated by a powerful solenoid actuated by the current from the main line. The solenoid plunger moves vertically and the switches open by gravity. There is no hinged or pivoted joint, and

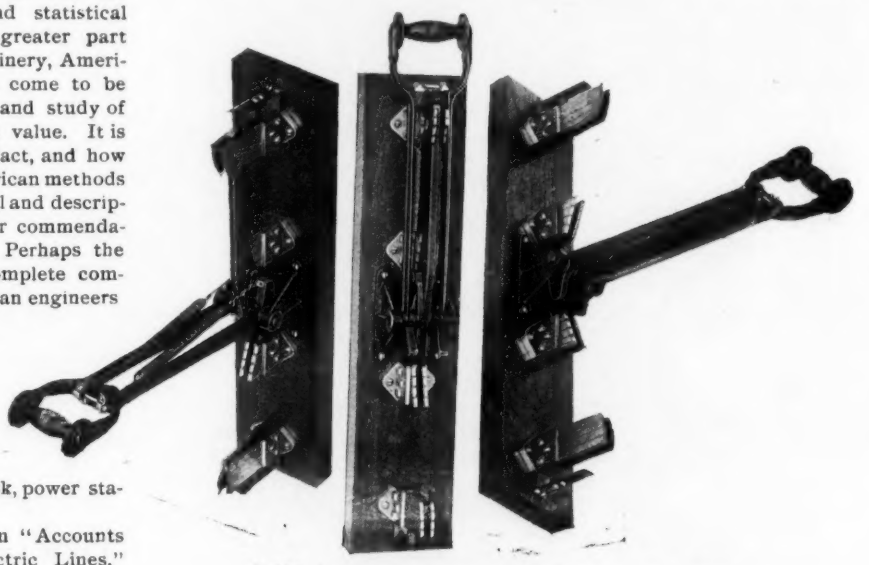


SWITCHES OF THE THIRD RAIL SYSTEM.

nothing to stick or catch. Two shoes are hung from the car to bear upon the third rail. When these two shoes, which are electrically connected, bridge a joint in the third rail the current flows from the rear one to the forward one, thence through the solenoid, which throws the forward section on to the main line and the rear section off. This process is repeated on every section that is passed. The switches are enclosed in solid cast-iron boxes, rendered water-tight by gaskets under their covers. These boxes are placed between the ties just inside the service rail. The small sizes of these boxes and the position in which they are placed renders the excavation necessary for their installation very slight.

A New Type of Switch.

The accompanying illustration shows a 500-volt 600-ampere switch of the new type put upon the market by the Hope Electric Appliance Company, Providence, R. I. The illustration shows the switch closed and the different positions of the switch in opening. The switch is opened by a



600-AMPERE SWITCH IN DIFFERENT POSITIONS.

smart blow from projecting lugs on the switch lever. This gives a quick movement which breaks the contact and permits the springs to carry the blades through 90 or 180 degrees as the operator may wish. An attachment is provided to lock the blade to or release it from the switch lever.

Train Acceleration Tests.

A series of additional train acceleration tests were made on Oct. 7 on the experimental track of the General Electric Company at Schenectady, N. Y., in the presence of Messrs. A. W. Sullivan, general superintendent, W. Renshaw, superintendent of machinery, and John Lundie, consulting engineer of the Illinois Central Railroad, and E. C. Carter, principal assistant engineer of the Chicago & Northwestern Railroad. Although the weather was most unfavorable and the runs made in a heavy downpour of rain, the results recorded are said to have been very satisfactory.

The Illinois Central Railroad has contemplated the adoption of electric traction in its Chicago suburban service, between Van Buren Street station and Woodlawn, a distance of about 8 miles, using the tracks over which that company carried on the World's Fair passenger traffic.

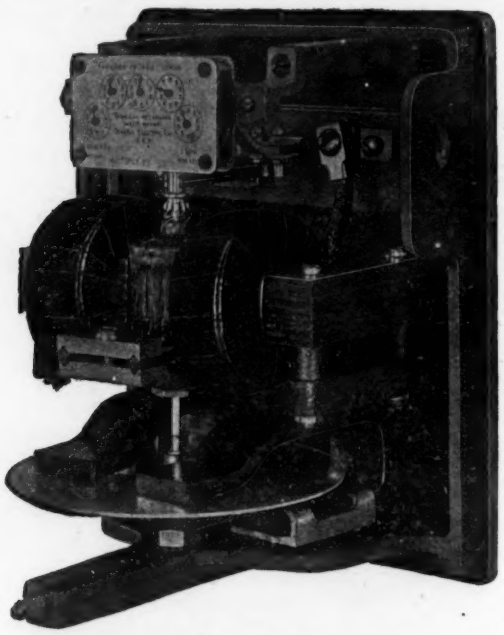
The car used on the occasion of these tests was a standard elevated railroad car, weighing, empty, about 25 tons. It was equipped with four 50-hp G. E. 57 motors, one mounted on each axle, controlled by a Standard series-parallel controller. In order that the officials present should be able to witness the actual performance of the car, the interior was equipped with voltmeter, ammeter, recording wattmeter and compensated chronograph, with bell attachment sounding at two-second intervals. Attached to one axle was a Boyer speed recorder, with the gauge on a level with the window.

A series of fourteen runs were made on the tangent of the experimental track—a stretch 3000 feet long, and the results on the wet track showed that in five seconds the car holding twenty people reached a speed of 19 miles per hour; in ten seconds, 30 miles per hour; in fifteen seconds 35 miles per hour, and 41 miles an hour in twenty seconds. This was with a wet and greasy track. During the latter half of the test the rain ceased and a second series of tests were made with a dryer track. The results were more favorable, and a speed of about 41 1-2 miles an hour in twenty seconds was obtained.

The tests are to be continued at Schenectady, under varying conditions; that is with different weights of cars and different equipment.

Recording Wattmeters for Street Cars.

The adoption of more careful and accurate methods in street-railway work is typical of the universal struggle for economy. The advantage of exact measurement of station output has long been recognized, and the requisite meters provided, but to record the ever-varying energy used on a car traveling over all conditions of road, involves difficulties almost unsurmountable. In the Thomson recording wattmeter for street-railway service however, the General Electric Company claims to have overcome all the obstacles. The new meter is intended for installation in the car, like a cash register. It records the actual energy used by the car. A few trials determine the proper energy consumption per car per trip under various conditions of track and traffic. Subsequent readings of the meter determine at once if energy is carelessly wasted, and thus serve as an effectual check on the motorman and the condition of the motors.



Mechanism of M

The simple motor construction of the car meter, as shown in the accompanying illustration, is similar to that of the other forms of Thomson recording wattmeter, but new conditions imposed by the rough service have been met by the careful design of the rotating parts. The General Electric Company claims high accuracy for its new car meter, and ability to withstand severe and continued use on the roughest tracks. The meter is now made for 500-volt circuits in sizes for 25 or 50 amperes, with a liberal provision for overloading.

A New Railway Motor.

In line with the G. E. 52 and G. E. 1000 railway motors, the General Electric Company announces a third, the G. E. 57. This is called forth by the success and popularity of the G. E. 1000, to which it is similar in design, but of greater capacity, while still as compact and simple. It is intended for heavy city and suburban work, and is suitable for service of that class either as a two or four-motor equipment.

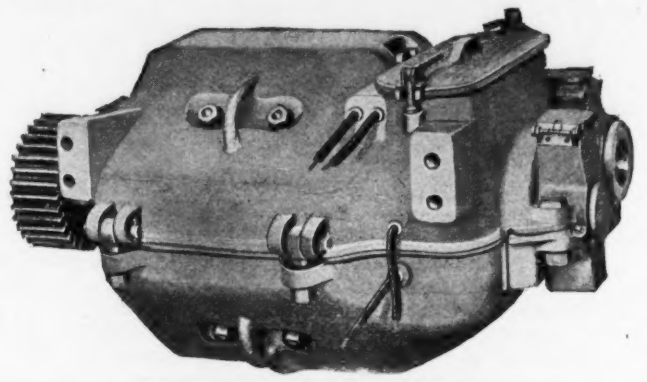
The G. E. 57 has an output of 50 horse-power at 500 volts, rated according to standard General Electric basis.

The frame is of similar construction to that of the G. E. 52 motor. It is steel, cast in two bowl-shaped pieces, with a hand hole in the lower half directly beneath the commutator. This permits free access to the bottom of the motor for inspection or cleaning. The frame is both water and dust proof. The motor has four laminated poles, each having a separate coil, held in place by the pole piece, which is bolted to the frame, the bolts projecting through the frame with lock and nut washer on the outside.

The armature bearings are designed and built on the "outboard" plan, and are so constructed as to allow free egress to the lubricant after it has passed through the bearing, rendering it impossible for it to work through into the motor frame. Either oil or grease may be used in the bearings.

The field coils are wound on cast spools thoroughly insulated with asbestos, mica and paper, and wound with copper ribbon insulated with asbestos. The upper and lower field connection is made on the outside of the motor, and all leads to the car are brought out on the front end. This has been found convenient in the car wiring and opening of the motors.

The armature is similar in construction to the G. E. 52 armature. It is small and compact, being 14 inches in diameter, with a spread of 12 inches,



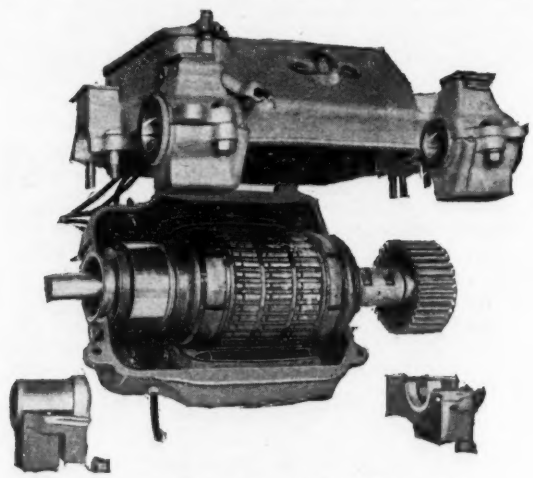
Front End of Railway Motor.

and has thirty-two slots. It is ironclad, the core being built up of well-annealed laminated discs assembled directly on the armature shaft. In assembling the core, three sets of spacing blocks are used, providing three ventilating ducts. There are thirty-three triple coils; each coil composed of three separate coils bound into a compact single unit.

A special effort has been made in the design of this motor to have the armature as light as possible without detracting from its electrical merit and efficiency. A light armature having small inertia presents special advantages in starting and braking.

The standard gear ratio is 3.72. A two-motor equipment with this ratio will propel an 18-ton car about 26 miles per hour on level track.

The commutator is similar in construction to the G. E. 1000 and has ninety-nine segments. The segments are of hard drawn copper 2 inches



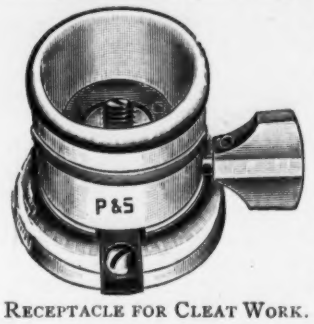
Railway Motor with Frame Dropped.

deep, allowing a wearing depth of 1 inch. The brush-holders are staggered to prevent the wearing of ridges in the commutator, and each holder contains two radial brushes 2 1-4 inches long by 1 3-4 inches wide by 5-8 of an inch thick.

The standard G. E. 57 motor is adapted to either the nose or the yoke suspension, as in the G. E. 1000 or the G. E. 52 motor. The motor can be fitted for side-bar suspension, but this necessitates a slight modification of the frame. The G. E. 57 motor without gear or gear case weighs 2632 pounds. With 67-tooth gear and gear case the weight of the motor complete is 2972 pounds.

A Key Pony-Receptacle.

For some time there has been a demand for a small receptacle for open wiring that can be operated by a key for turning on or off the lamp it contains. The keyless form has been produced, as has also the key receptacle for concealed work, but nothing for cleat work. Recognizing this demand Messrs. Pass & Seymour, Syracuse, N. Y., have just put upon the market a key pony-receptacle for open work. This receptacle will be found very useful in show windows or other locations where it is desired to have each lamp controlled independently.

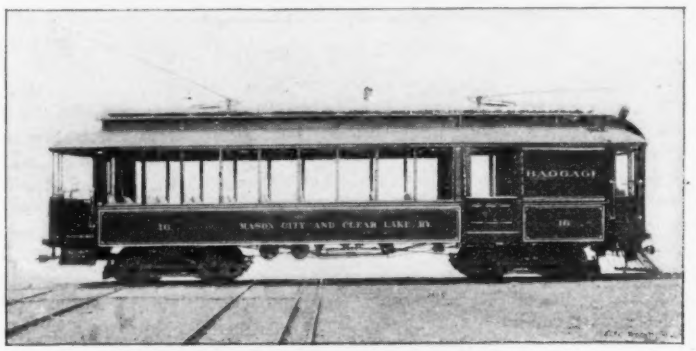


RECEPTACLE FOR CLEAT WORK.

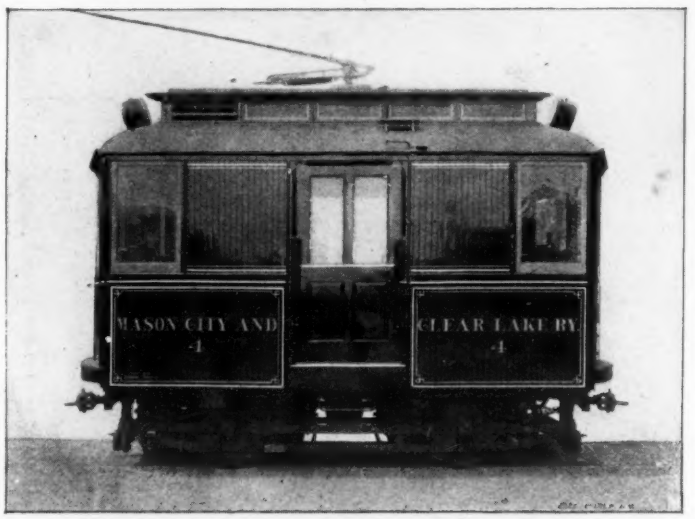
The porcelain used in all the goods manufactured by this company is the well-known "Syracuse China." It is the same material that enters the manufacture of the highest class of table ware manufactured in this country.

Some Special Electric Cars.

On the Mason City & Clear Lake Traction Company's line, Mason City, Ia., there is run a Pullman car 45 feet long, which is shown in the illustration. The body of this car weighs 7000 pounds. It is mounted on Peckham extra strong No. 14 trucks, equipped with four 50-hp Walker motors. The schedule speed on which this car runs is 35 miles per hour, but the car easily runs up to a speed of 48 miles per hour. It is often used to haul six loaded 40-foot trailers, and occasionally used for switching freight cars, six or eight of which it handles with ease. The same company has an electric switching locomotive mounted on a single Peckham extra strong standard truck, and equipped with two 75-hp Walker motors. It hauls and switches six loaded freight cars without difficulty. An illustration of this locomotive is also shown.



COMBINATION CAR.



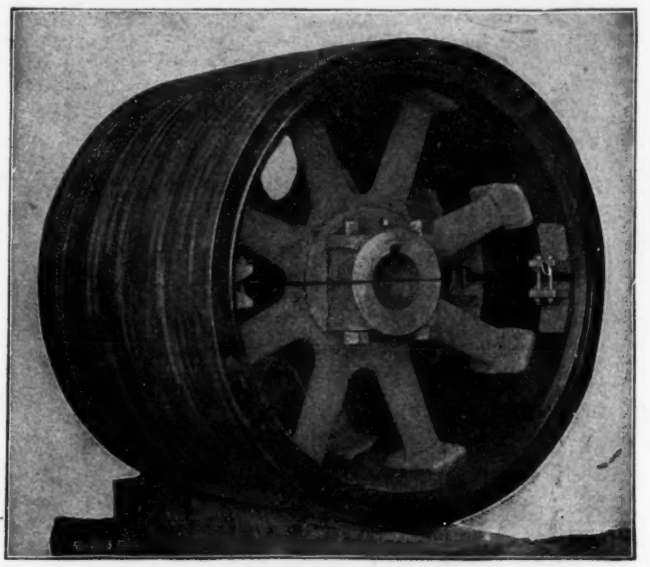
SWITCHING LOCOMOTIVE.

Improved Microphone.

Constant efforts have been made to improve the microphone transmitter as used in the telephone, and as a result many forms of this very essential instrument have been produced. Mr. William M. Snyder, 216 Mill Street, Germantown, Philadelphia, Pa., has brought out a form of microphone which he claims can be operated on interior and long-distance lines with a smaller battery than is usually required for such service, and at the same time secure clear enunciation. The instrument is known as the "Volo" microphone, and Mr. Snyder commends it as an article of real merit. In using this instrument there is said to be a noticeable absence of the thick sounds and the jumbling of words, which is an effect very often experienced in using the ordinary telephones. The smoothness of the sounds and the absence of harsh, grating noises are also noticeable features, and the clear tone gives the impression that the speaker at the other end of the line is but a short distance away. The transmitter is claimed to be equally reliable for interior and exterior work. It is so constructed that packing is avoided, and it cannot get out of order.

Special Dynamo Pulley.

The accompanying illustration represents the special dynamo pulley made by the Dodge Manufacturing Company, Mishawaka, Ind. This pulley, which has been on the market for a number of years, is well worthy of the consideration of electrical engineers. It has been very generally adopted by manufacturers of generating apparatus, which fact is a positive evidence of its merits and popularity. The manufacturer claims for this pulley a superior belt transmission surface; reduction in belt tension and journal friction to a minimum; an almost noiseless and perfectly balanced pulley; great strength, and freedom from danger of explosion. The special dynamo pulley is made with double arms and of heavy construction. It is 71 inches in diameter, has a 52-inch face and will stand an accidental strain of 1000 horse power. This pulley has been used with great success on electric motors and dynamos in every State in the Union, and at the World's Columbian Exposition it did the very heaviest of service, and is said to have been the only special pulley recognized by an award.



DYNAMO PULLEY.

The Dodge Manufacturing Company is catering to the wants of the electrical trade, and its aim and efforts are being constantly directed toward the perfecting of power-transmission machinery. Among the various lines of manufactures produced by this company may be mentioned the patent split friction clutch, shafting, hangers, automatic oiling bearings, in addition to its "Independence" wood split pulleys. A 1200-hp rope drive was installed at the Niagara Falls paper mill, Niagara Falls, N. Y., some time ago, and it has been giving the greatest satisfaction in operation. The company maintains agencies in all the commercial centres of the world.

Electric-Elevator Controllers.

The accompanying cuts illustrate a type of electric-elevator controller designed to fill a constantly growing demand from the old manufacturers of steam and hydraulic elevators, who realize the fact that electric elevators are here to stay, and are preparing to furnish them.

Figure 1 is a front view, showing a cross head, carrying renewable carbon brushes, and falling slowly by gravity, retarded by a dash pot. A heart-shaped cam, pressing against a steel roller in the cross head, serves to lift the cross head positively, and insert all the resistance.

The segments are made of long, narrow strips of copper, similar to a motor commutator. They are set up from the slate, are reversible and interchangeable, and can be easily and cheaply renewed, without disturbing any of the electrical connections. When desired to insert resistance into the shunt field of the motor for the purpose of increasing its speed.

extra segments are inserted between the two rows of armature segments. Fig. 2 shows the reversing switch, the automatic release switch, and the time limit overload device. The reversing switch is moved positively by a crank pin, keyed to the main shaft and engaging with the forked projection on the reversing lever. The first movement of the main shaft sets the reversing switch in the desired position, with all the contacts fully made. A further movement of the shaft causes the small solenoid shown

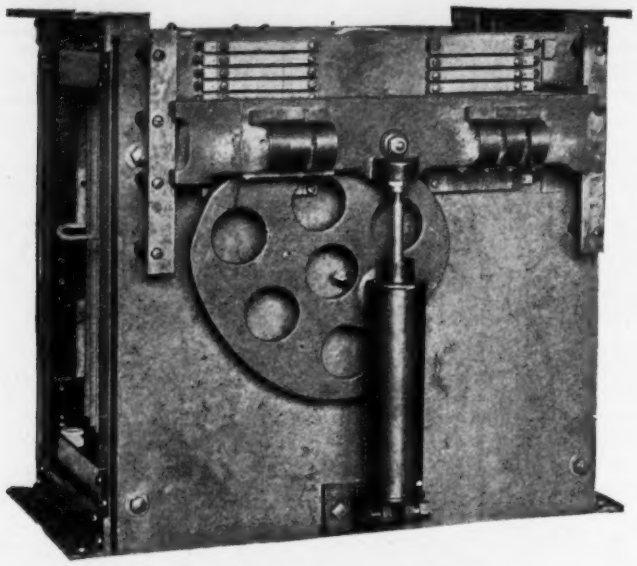


Fig. 1.—Front View of Controller.

in the illustration to become energized, and the circuit is thus finally closed with a snap. This construction makes it impossible to leave any of the switches partially closed, thereby causing bad arcing and burning, and also opens the circuit on failure of the current supply. The overload magnet de-energizes this solenoid, should an abnormal current flow sufficiently long to overheat the motor.

In order to start the motor after the supply of current has failed, or the

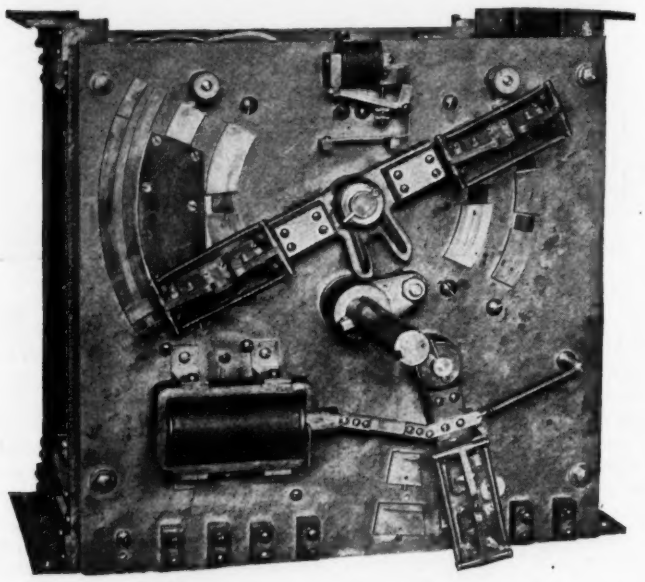


Fig. 2.—Reversing and Automatic Release Switch.

overload has operated, it is only necessary to put the controller shaft on the centre, by the movement of the hand-cable in the car, in which position all the resistance of the controller is in circuit with the armature.

These controllers are compact and well built, and have been in successful operation a sufficient length of time to warrant calling the attention of the public to their merits. They are manufactured by the Cutler-Hammer Manufacturing Company, of Chicago.

A New Street-Car Controlling System.

In The Electrical World of July 31, 1897, was described a commutative railway system which had been developed by Mr. J. C. Henry, of Denver, Col. This system required the use of three conductors, by which three different voltages could be transmitted to the car. Mr. Henry has been recently allowed patent claims on a system somewhat similar, but applicable to ordinary street railway work. In this new system shunt motors are used, the field windings being connected in series with each other and with an adjustable rheostat. The controller, which is operated by a single handle, is arranged to throw the armatures in series or multiple, and also to adjust this field rheostat. In the series motor, as is well known, it is impossible to raise the back E. M. F. of the motor above that of the supply system. With a shunt motor, however, if the excitation of the field is increased while the motor is running, the back E. M. F. may be made greater than the impressed E. M. F., in which case the motor will return energy to the line.

In the system herein described this feature is made use of. The car is started with the two motors in series and the two fields at full strength. Acceleration is gained by weakening the fields and finally throwing the motors in multiple. On reversing the movement of the controller handle the fields are strengthened again, which tends to retard the car, returning the kinetic energy of the car to the line. As the car slows down the motors are thrown in series again and the fields gradually strengthened until the car reaches a speed of about 5 miles an hour. Below this speed further retardation is produced by short-circuiting the motor armatures with the fields properly excited.

In the record of electrical patents in this issue is an illustration of a special controller designed by Mr. Henry to accomplish this purpose. Although the use of a shunt or separately excited motor reduces the tendency to arc, this controller embodies several principles for preventing arcing. This is for the reason that the controller was designed for use on a 2000-volt circuit. The changes of connections are made in a closed receptacle containing carbonic acid or other gas, which will not support combustion. Where this does not suffice, the gas under heavy pressure may be injected against the arc at the instant of breaking the circuit.

A Direct-Reading Potentiometer.

It is now generally recognized that no method can compare with the potentiometer method for quickly and accurately calibrating voltmeters and ammeters. The only possible elements of change are the standard resistances and the standard coil. As to the former, the experience of many years has shown that the percentage of change in thoroughly well-made resistances used with any kind of care is extremely small. That the resistances should change among themselves is still more unlikely, and it is merely their ratios that require to remain constant. Standard cells cannot be relied upon quite so thoroughly—still experience has shown that even the standard cell may be depended upon not to change in value by more than 4 or 5 parts in 10,000 in several years' use. Standard cells are cheap and easily replaced even if they do change, while the resistances may easily be checked up among themselves for inaccuracy at any time, by use of an ordinary Wheatstone bridge.

Messrs. Willyoung & Co., Philadelphia, Pa., have recently placed upon the market through their selling agent, Mr. James G. Biddle, a new form of direct-reading potentiometer, which is illustrated herewith.

Figure 2 shows the component parts of the apparatus in diagram, while in Fig. 1 the instrument, complete, is represented.

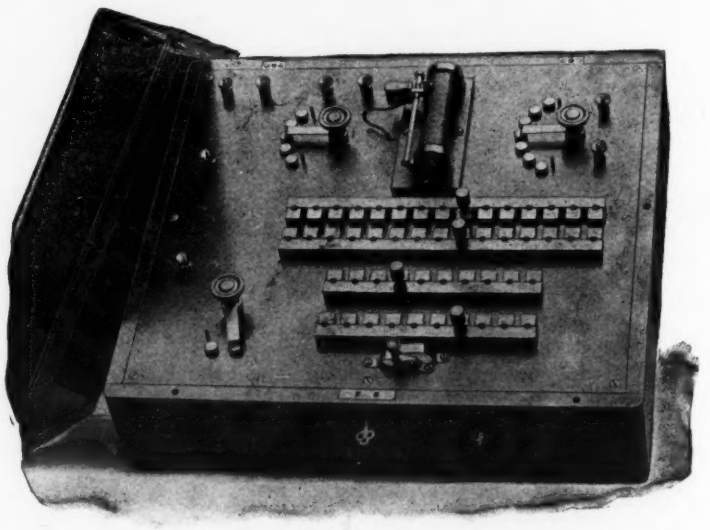


Fig. 1.—Potentiometer.

The main potentiometer circuit contains three groups of adjusted resistances, viz., "quick," medium" and "slow." There are nine coils in "slow," each of 0.08 ohm resistance. "Medium" has nine coils also, each of 0 8 ohms resistance, or ten times that of a coil of "slow." In "quick" there are two sets of coils, fourteen in each set, and each coil of 8 ohms resistance. By means of this "quick" group, if plugs are kept in corresponding holes of both bars, resistance may be taken out from between the galvanometer circuit terminals, while maintaining the resistance of

the main circuit always constant. The coils of "quick" are designated consecutively 0 1, 0.2, 0.3, 0.4, etc., up to and including 1.4; those of "medium," 0.01, 0 02, 0 03, 0.04, etc., up to, and including, 0 09, and the coils of "slow," 0.001, 0.002, 0.003, 0.004, etc., up to and including 0.009.

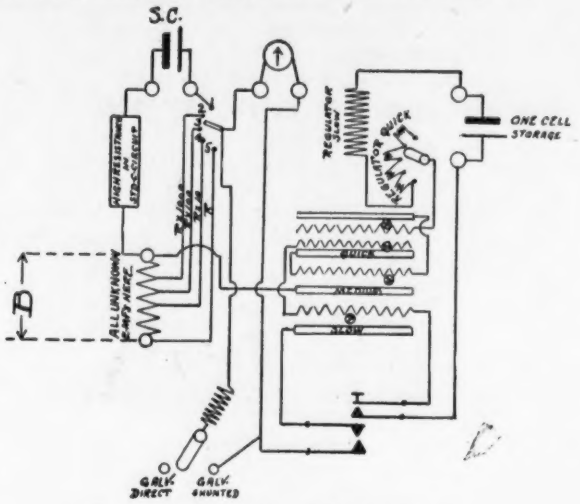


FIG. 2.—DIAGRAM OF CONNECTIONS.

The potentiometer is capable of measuring E. M. Fs. up to 1000 volts with an accuracy of 1-10 per cent. Currents of any value may be measured by means of a standard known low resistance; the unknown current should be passed through this, and the potential difference produced by this current at the terminals of the resistance measured by the potentiometer.

Overhauling Storage Batteries.

In THE ELECTRICAL WORLD of Aug. 7 last was described an improved electro-chemically prepared insulation for storage batteries as applied by Mr. J. E. Haschke to the Palmer House storage-battery plant in Chicago. This plant is reported now to be in excellent condition. Mr. Haschke has

BUCKLED PLATE.

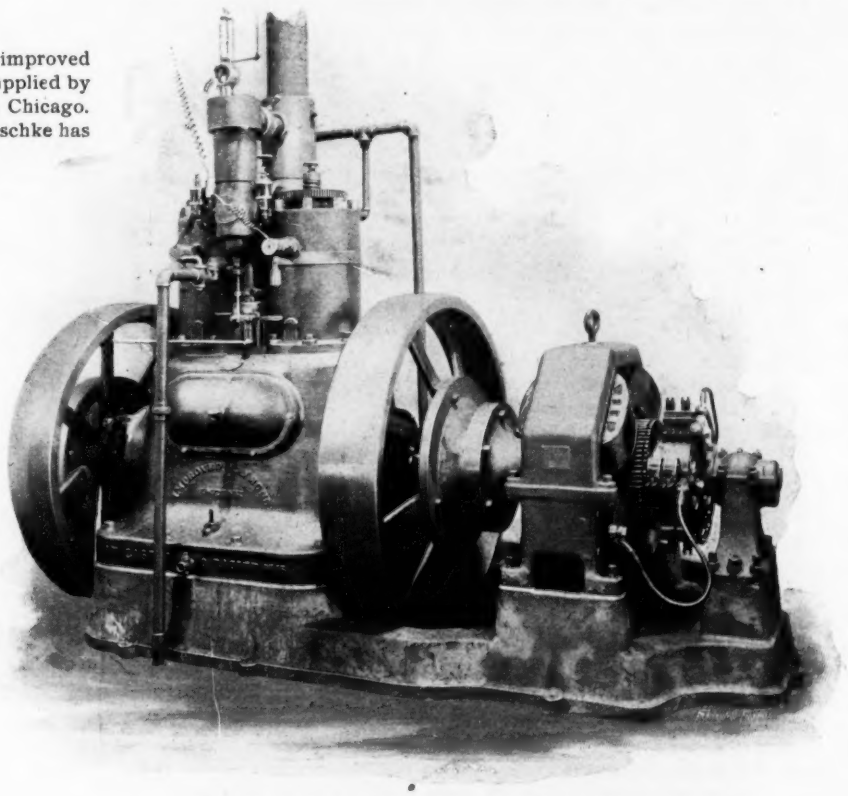
also overhauled the battery of the West Side Brewery in Chicago, and installed his prepared insulation in the cells located there. This battery consists of a plant of 58 cells, containing three negative and four positive plates, of the New York Accumulator type. It was installed about two years ago, and has already deteriorated seriously, as will be seen from the accompanying cut, which illustrates the appearance of one of the outside positive plates. The cause of this serious buckling was probably due to the fact that only one side of the plate was exposed to the effect of chemical action. The only insulation of this cell was glass strips about 12 inches long, 1 inch wide and ¼ inch thick, consequently buckling of the plates rendered them useless in a very short time. The cells were then left idle for some time, and the solution was allowed to evaporate. The active material fell from the plates and the plant was considered worthless. A few months ago all the positive plates and a part of the negative plates of this battery were repasted and overhauled on the Haschke system. Each positive plate in the battery was enveloped in a single sheet of the improved insulation, and the mass was tightly banded together, thus bringing the plates about ⅛ of an inch apart and reducing the internal resistance considerably. Free circulation of the electrolyte is not necessary between these plates as the chemical properties of the insulation material assist the chemical action of the cell. This holds up a high-constant voltage during the discharge.

Improved Gas Engine.

The gas engine as a prime mover in electric-light work is growing more and more in popularity, and this tendency is being met by the manufacturers of these machines in constant improvements, with the object of fitting them to meet the exacting requirements of electrical work.

Among the concerns who have given special attention to the improvement of gas engines is the J. I. Case T. M. Company, of Racine, Wis. The Raymond improved gas and oil engines manufactured by this company are considered among the leaders of this type of engines. The Raymond engines are made with single, double and quadruple cylinders, ranging from 1 to 100 horse-power. The three styles of engines embody the same mechanical principles. The bases of all three are cast in one piece, varying only in size. To these are securely bolted the vertical cylinders which are cast separately, and with a water jacket in which the cooling water circulates. The heads of the cylinders are separately cast with water jackets and are fitted to the cylinder with a carefully ground joint. These heads form the combustion chambers and contain the rotary valves, starter, igniters and inlet and exhaust ports.

The rotary valves are operated direct from the crank shaft by a set of spur gears, and are lubricated from sight feed cups. The pistons are of the trunk form, open at the bottom, and are of sufficient length to serve as a cross head for the direct attachment of the connecting rods. The piston valve and lever are in direct connection with the shaft governor. Where gasoline and other oils are used, the vaporizing device is placed on



GAS ENGINE AND DYNAMO COMBINATION.

top of the inlet casing, and the needle valve which governs the supply is also in direct connection and controlled by the shaft governor. All engines are furnished with two driving pulleys. To the arms of one of these pulleys is bolted a band pulley in which the shaft governor operates and to which may be belted line shafting. The dynamos and high-speed machinery are belted direct to the driving pulleys.

Either natural, producer, water or fuel gas of any kind can be used. The ignition of the gas mixture is accomplished by electricity, through the operation of a patent electric igniter connected with storage or primary electric batteries. This method of ignition is also adopted where gasoline is used to operate the engines. These engines are said to be instantly interchangeable from gas to oil, and vice versa, while the engine is running, and this change can be made without any noticeable variation in the speed of the engine, even when driving a full load of electric lights. The advantage of this is obvious where the supply of one kind of fuel may become exhausted. These engines can be started by any intelligent person

without delay, and the speed regulated or changed without stopping the machine.

The company's patent starter offers the true solution of the problem of starting gas engines with certainty, and the largest engines manufactured by this concern are started with as little effort as the smallest. The starter is very simple in construction, requires no adjustment and can be operated by anyone.

The governing device used on these machines consists of an automatic shaft governor which is placed in one of the fly wheels. It is constructed on the improved centrifugal principle and regulates through the piston valves the exact amount of gas mixture required for each impulse to maintain a perfectly steady speed under all conditions and variations of load. It is stated that this governor is so sensitive and accurate that scarcely 2 per cent. difference in the speed of the engine can be discerned in throwing on or off a full load of electric lights, or any part of the same, the governor and valves regulating instantly the exact amount of gas mixture required to keep a uniform speed and a perfectly steady light.

The valves are constructed on the rotary principle. They are placed in the top of an explosion chamber and receive their motion from a set of accurately cut spur gears direct from the main crank shaft. When in operation the tendency is for the valve to keep perfectly seated, allowing of high compression and obviating the necessity of frequent cleaning and grinding. They are noiseless when in operation.

It is claimed that this engine develops the greatest amount of power from a given amount of gas or gasoline. Engines of this make are driving electric light plants on 12 cubic feet of natural gas per hp-hour for actual power developed, which is claimed to be superior to the best figures for economy of any make of gas engine. The company guarantees it to run on 15 cubic feet. The oil engines are guaranteed to run on 1-10 of a gallon of 74° gasoline per hp-hour, but engines of this make are in actual service that require only about two-thirds of this amount. The company reports that one of its 50 hp double-cylinder engines belted directly to a 50-hp Thomson-Houston arc dynamo and producing 52 arc lights over 28 miles of wire, performed the work, by actual test, as follows: Figuring one arc light per horse-power, 52 horse-power was developed on five gallons of 74° gasoline for one hour and forty-seven minutes, or 1-18 of a gallon per hp-hour.

The company warrants these engines to be well constructed, and, when sold to operate an electric-light plant, to produce good, steady, commercial electric light when belted or coupled direct to a standard dynamo; also to deliver their rated horse-power at the belt, on 12 to 20 feet of gas, according to quality, or 1-10 of a gallon of 74° gasoline per hp-hour for each actual horse-power developed. The company also guarantees its engines to stand an overload of from 15 to 25 per cent. for a short time without injury.

To sum up the advantages of these engines, the most important features to which attention is directed are the manner of driving the dynamos; the close regulation of the machine; manner of governing; connection to both gas and gasoline at the same time and ease of change from one to the other; method of starting, which is done with a shell of powder; manner of lubricating, and the way in which every engine is tested.

The illustration on the preceding page represents one of the double-cylinder engines for 30 horse-power connected direct to a dynamo.

A New Telephone System.

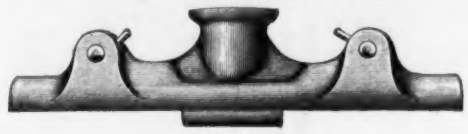
In ordinary telephone practice an average of not more than 10 per cent. of the wires is in use at one time, some 90 per cent. or even more representing idle copper. In large exchanges the cost of the conductors and the maintenance of the same is a very serious charge. The telephone business is peculiar, in that the larger the system the more expensive is the service per subscriber. To reduce this large expense the Smith-Vassar Telephone Company has brought out a new system by which the number of wires necessary for a given number of subscribers is greatly reduced. The party-line system is utilized with a new individual-call system and thoroughly developed devices for preventing interferences or listening-in between subscribers on the same party lines. Each single party line is made to accommodate quite a large number of subscribers, and is provided with a sufficient number of wires to supply the greatest number of simultaneous conversations liable to occur in that party line. For example, a line supplying 100 subscribers would be fitted with fifteen or twenty wires, sufficient to carry the maximum number of conversations at the busiest period of the day. For small country towns and villages all the subscribers could be placed on one such party line, thus doing away with central-office attendants entirely. For larger cities the system would be divided up into districts covered by party lines, the separate districts being connected by a central-office switchboard.

The instruments, which are now on exhibition at the office of the company, 27 William Street, New York City, are very ingeniously equipped for selective calling and for the avoidance of interferences. The selective call system works as follows: Each division of the line between two subscribers is normally looped on itself, the transmission of an impulse from any one subscriber station to the relay of the next station opening this loop and throwing in the next section. By sending a series of impulses, a number of sections equal to the number of impulses is thrown into the circuit. The intermediate stations are all cut out when the calling signal is sent; only the station wanted is rung up.

The instruments are also fitted with an automatic device for keeping them off from the busy wires of the line. The expense of running such a system as this should not increase in nearly as great a ratio as the expense of the ordinary Bell system, which should give the new system a very strong hold in any competition.

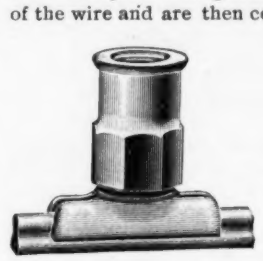
The Luscomb Clip for "8" Wire.

The increasing use of the figure "8" shaped and similar forms of wire has called for the invention of various devices for their support. To this shape of wire a mechanical clip can be most readily adapted, since at no time is it necessary for the trolley wheel to come in contact with the clip or ear; and the essential features to be covered in any practical or successful device are great strength, simplicity and reliability, combined with cheapness.

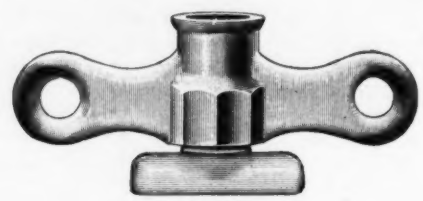


Splicing Clip.

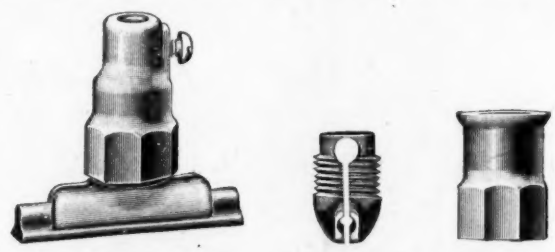
The Luscomb clip illustrated herewith has been designed to meet the above-named requirements. The clip consists of two parts, a split clamp, hinged at one end by a thread of metal, as illustrated, and the hexagona nut. The jaws having been slightly spread are forced over the upper ridge of the wire and are then compressed by means of the nut which furnishes the clamping power and also the threaded socket for the attachment to the trolley hanger. The Luscomb clip is, of course, also adapted to the clover leaf and other sections of wires having similar features. The clip is illustrated in four forms, the straight line clip, the feed-in, the strain and the splicing. The latter automatically grasps the ends of the wires and holds them firmly in place by means of hinged dogs, which bite into the wire when under strain. The simplicity and strength and the ease with which the clip may be placed upon the line and attached to the hanger, highly commends it as offering a most practical and reliable form for effecting the attachment of such wires to their overhead supports. The Luscomb clip is sold by the H. W. Johns Manufacturing Company, New York.



Feed-in Clip.



Strain Clip.



Straight Line Clip, Split Clamp and Nut.

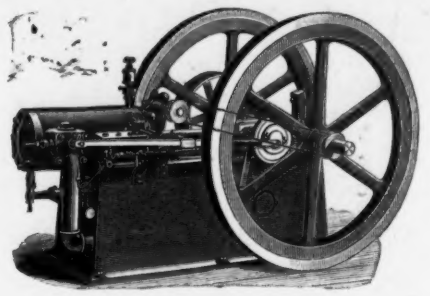
Gas and Gasoline Engines.

The gas engine is rapidly coming to the front as a prime mover for electric-generating apparatus, and for this reason electrical engineers are more or less interested in the development of these machines, which are receiving considerable attention at the hands of experimenters and inventors.

The Foos gas and gasoline engines, manufactured by the Foos Gas Engine Company, Springfield, Ohio, are said to be excellently adapted for all power purposes. In its construction it is very simple, and in operation it is both efficient and economical. These engines are provided with the poppet valve, which is considered by the manufacturer as the one best adapted for running engines on any kind of gas or gasoline of proper test. All valves on the engines are positive in their operation and are of ample sizes to secure the highest efficiency without putting them to the severest

test. These engines will run on illuminating or fuel gas, made from either coal or oil, natural and producer gas, as well as on gasoline of 74° or higher test. It is stated that they run with practically no noise, which feature renders them desirable for use in private dwellings and office buildings, etc., where freedom from noise is an essential requirement.

The company has improved its electric igniter so as to render it very reliable. The governor of the engine, which is of the centrifugal type, is exceedingly sensitive and controls with the greatest accuracy the admission of gas or gasoline. The speed can be increased or decreased, if desired



GAS ENGINE.

while the engine is running. In operation the engine gives a steady uniform speed, which renders it peculiarly fitted for use in electric light plants.

The company guarantees a consumption under full load of about 18 cubic feet per brake horse-power per hour with coal gas of fair quality, and about 12 cubic feet with the average quality of natural gas.

The Foos engines are built in sizes ranging from 2 to 100 horse-power, but larger sizes can be furnished, if desired.

Improved Electric Car Truck.

Before the advent of the electric railway such a thing as a truck for four-wheel street cars, as it is known to-day, was practically unknown and unthought of, the car body furnishing ample support for the simple running gear. With the introduction of electric power for the propulsion of street cars came the necessity for a stronger and more elastic support for the heavier car body and electrical mechanism. This necessity was soon realized by the J. G. Brill Company, of Philadelphia, and without encouragement and in the face of great difficulties it built and experimented with numerous designs. A large amount of money, skill and time has been directed to the development of the motor truck by the firm. If we are not mistaken, it has built and tested by actual service on street railways more than forty different types and styles intended to meet the different requirements of service.

A recent pamphlet issued by the J. G. Brill Company is devoted to what the company calls its "Perfect" truck—the No. 27 in its regular list. This truck has now been in operation rather more than two years, and has developed a number of excellent features. Some of these were entirely unforeseen at the time when the first truck of the class was constructed. The first pair of these trucks was put upon the Buffalo & Niagara Falls Electric Railway as an experiment, and in adding to its equipment the road ordered the new trucks, and finally threw away all the other trucks, replacing them with the No. 27.

One of the remarkable features of the truck was the fact that it never appeared to leave the rails. Manager Van Horne, of the Buffalo & Niagara Falls Railway, wrote some time since that none of these trucks had ever left the rails, and in a more recent letter the gentleman states that the record is still unbroken. The "Perfect" trucks are now on the suburban roads running out of Cleveland, Ohio, and up to this time the first derailment is yet to be reported.

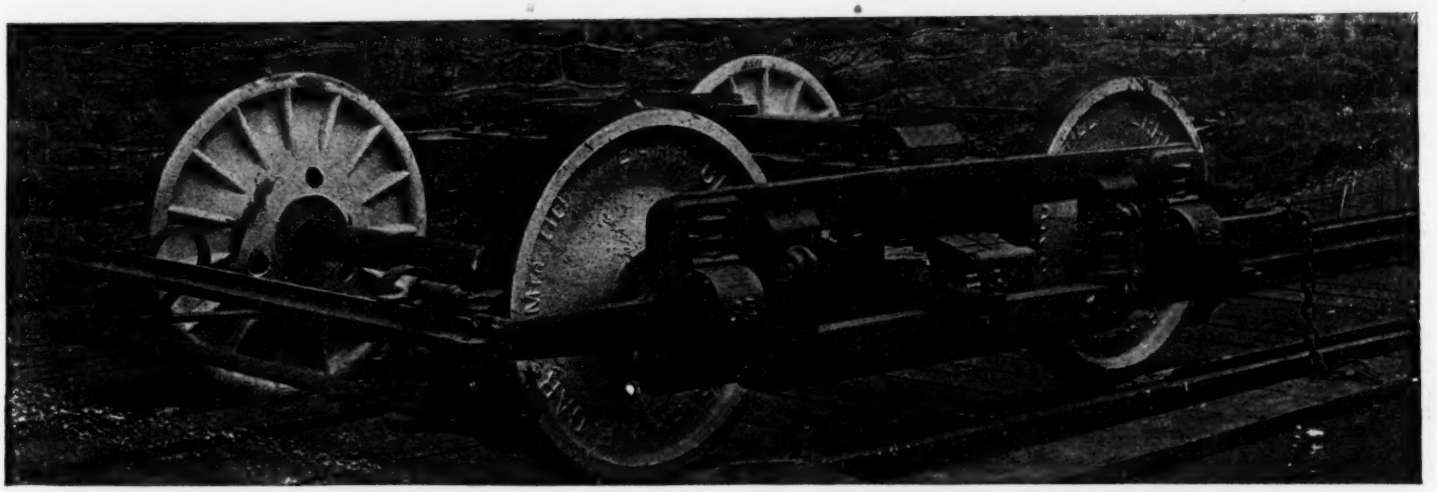
This remarkable safety is due to several noteworthy characteristics. The first of these is the fact that the load upon each wheel is always perfectly uniform, and cannot be increased nor diminished by irregularities of the track. The second is that the swinging and cushioned side motion prevents any undue pressure from being brought upon the flanges. It is load, and not leverage, on the journal boxes, and the ends of the truck do not cant nor lift when the brakes are applied.

Experience developed the fact that the No. 27 truck could run safely over T-rails with the narrow-tread wheels having the shallow flanges. It has been found perfectly safe to make 50 miles per hour with this truck mounted on these wheels.

In the ordinary M. C. B. standard equalized truck the wheels are at the end of a lever, while the spring is near the fulcrum. A small obstacle or irregularity may therefore cause the wheel to jump. In doing this there is a moment in which the wheel does not have the normal share of the load, its leverage against the spring being nearly 2 to 1. In the No. 27 truck, however, the load rests almost directly upon the journal springs, being distributed to them by the spring links at the ends of the equalizers, and the wheels have no leverage against the springs. Even in the most rapid running over an uneven track there will be no instant in which any wheel will be relieved of its share of the load. To this and to the great longitudinal stability of the truck is due the pertinacity with which it adheres to the rails.

The behavior of the truck under the action of the brakes is claimed to be ideal. No matter how sharply the brake may be applied, even in the fastest running, there is no canting or tipping up at the ends. This is due to the wide separation of the links longitudinally, bringing the weight directly upon the journal springs, which reduces the leverage of the brakes upon the truck to such an extent that it ceases to affect the springs. Under these favorable conditions there is naturally a great increase in the comfort of the passengers and the smoothness of motion. Another important advantage is found in the application of the air and power brakes.

Among the special advantages claimed for the No. 27 truck are easier riding under all conditions of track, greater difficulty of derailment by obstructions, no tilting of the truck upon applying the brakes, less danger at frogs and switches, and equal loads on all the wheels at all times. There will also be a very considerable decrease in the wear and tear upon the rails, due to the absence of pounding and the general smoothness of action.



NO. 27 "PERFECT" TRUCK.

A Storage Battery Railway.

The Englewood & Chicago Electric Storage Battery Railway has been operating now for four months. All sorts of dire predictions were made when the road was started, but its operation seems to belie them all. There are 30 miles of track now in use, and several miles more will be added this winter. The average running speed is over 12 miles an hour, rising to 14 miles at night. Cars have been run up to a speed of 37 miles an hour. The officials claim that an ordinary motor car will run over the road hauling one trailer at the rate of 30 miles an hour without difficulty. The cars of the road are very heavy, weighing 18 tons each. The storage batteries are placed in a tray hung from the truck.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, October 11, 1897

ELECTRICAL STOCKS were much weaker last week, and in no instance is an advance recorded. Edison Electric Illuminating of New York declined 1 point, and both the Electric Storage Battery issues are lower. General Electric lost 1½ points. The sales of this stock for the week amounted to 13,605 shares. The highest price reached was 38¼, and the lowest 35¾. The preferred issue of General Electric is down 3 points.

TELEGRAPH AND TELEPHONE.—American Bell closed the week with a substantial net advance. Western Union is lower, having closed with a net loss of 2 points. The highest point reached was 91⅞, and the lowest 88¾. The total number of shares of Western Union sold during the week was 22,559. Other telegraph stocks remained practically unchanged, and the same may be said of the telephone issues, excepting American Bell.

ELECTRIC TRACTIONS.—These securities were generally weaker, and closed the week with fractional losses. Columbus Street Railway was the strongest and most active feature of the list, but no change of price is recorded. Brooklyn Rapid Transit closed with a net loss of 1⅛ points, the number of shares sold during the week amounting to 12,985. The range in fluctuation of prices was from 35, the highest, to 31¾, the lowest, closing at 32¾.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	126	..
Edison Electric Ill., New York	100	125	130
Edison Electric Ill., Brooklyn	100	..	110
Edison Electric Ill., Boston	100	147	148
Edison Electric Ill., Philadelphia	100	..	..
Edison Ore Milling	100	7½	10
Electric Storage Co., Philadelphia	100	29⅞	30¼
Electric Storage, pref.	100	32	32½
General Electric	100	35¼	36
General Electric, pref.	100	▲82	85
Westinghouse Consolidated, com.	50	23	24
Westinghouse Consolidated, pref.	50	54	56
BONDS.			
Edison Electric Ill., New York, con. 5s	105	110½	..
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	100	..
TELEGRAPH AND TELEPHONE.			
American Bell Telephone	100	.	266
American District Telegraph	100	..	30
American Telegraph and Cable	100	..	93
Central and South American Telegraph	100	124	127
Commercial Cables	100	175	..
Erie Telephone	100	74½	..
New England Telephone	100	133	..
Postal Telegraph Cable	100	99	101
Western Union Telegraph	100	83¾	89
ELECTRIC TRACTION STOCKS			
Baltimore Traction	25	18¾	19
Brooklyn Rapid Transit	..	32½	33
Brooklyn Traction	100	..	14
Brooklyn Traction pref	100	46	48
Buffalo Street Railway	100	76	78
Cleveland Electric Railway	100	..	..
Columbus Street Railway	100	47	49
Hestonville	100	46½	47½
Hestonville, pref.	..	..	62½
New Orleans Traction	100	5	7
New Orleans Traction, pref.	100	..	25
North Shore Traction	100	..	20
North Shore Traction, pref.	100	..	80
Rochester Street Railway	..	17	19
Steinway Railway	..	45	50
Union Railway (Huckleberry)	..	110	..
Union Traction, rcts $10 pd	..	12¾	13
West End, Boston	100	94½	95
West End, Boston, pref.	100	100	..
Worcester Traction	100	16	18
Worcester Traction, pref.	100	93	95
BONDS.			
Brooklyn Rapid Transit 5s, 1945	100	91	..
*Buffalo Street Railway 1st con. 5s	100	109	111
Cleveland Electric Railway 1st mtge., 5s	100	102	104
*Columbus Street Railway 1st 5s	100	95	97
Rochester Street Railway 1st 5s	100	90	..
Union Railway (Huckleberry) 1st mtge. 5s	.	107	111
*Westchester Electric 1st mtge. 5s	100	100	103

*With accrued interest.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, October 14, 1897.

NEXT YEAR'S ELECTRICAL SHOW.—We are informed by Mr. Marcus Nathan, general manager of the Electrical Exposition Company, that a lease has been taken of the Madison Square Garden Building for the electrical and kindred industries exhibition which will be held in May, 1898. The lease includes the amphitheatre, arena circle, concert hall, assembly hall and machinery hall in the basement. The total floor space amounts to over 100,000 square feet, and it is well adapted for the purposes of an exhibition.

SERVICE STRIPES FOR STREET RAILWAY EMPLOYEES.—The Metropolitan Street Railway Company, of this city, has decided to introduce a system of recognition of faithful and long service of its employees. For each year of service up to and including four, each employee will wear one blue stripe on his coat sleeve. After the first five years all blue stripes are to be discarded and replaced by one gold stripe, and for every subsequent five years of service another gold stripe will be added. Some of the present employees of the road have been in the service for over thirty years.

AN INJUNCTION has been granted by Justice Gaynor of the Supreme Court in Brooklyn on behalf of certain stockholders of the State Electric Light & Power Company, restraining the Amsterdam Electric Light & Power Company from carrying on its business under the franchises and privileges of the State Electric Light & Power Company; prohibiting the State Trust Company from foreclosing an alleged illegal mortgage on the property of the State Electric Company, and restraining Noah L. Cocheu, president of the State Electric Company and general manager of the Amsterdam Company, from conducting any business of either company. The papers allege that Mr. Cocheu manipulated the stock of the State Electric Light & Power Company in such a manner that he became sole owner of the business; that he entered into a contract with the Amsterdam Company, by which that company secured the control of the plant, franchises and properties of the State Company, and that the Amsterdam Company, with certain other parties, combined to wipe out the stockholders and direct creditors of the State Electric Company, by foreclosing the mortgage above referred to.

THE EDISON ILLUMINATING COMPANY'S TAXES.—On October 6 Judge Hurd, in the County Court, handed down a decision in the application of the Edison Electric Illuminating Company for an order to compel the Common Council to restore certain taxes on the personal property of the company. The decision holds that companies paying a direct State tax cannot be locally assessed on their personal property for State purposes. The application was made under a law passed in 1880, and the decision is based on the same act. This law provides that corporations paying a direct tax to the State cannot be locally assessed for State purposes, except on their real property. The law seems to have been generally forgotten. It is stated that this decision is far-reaching, and if sustained, many corporations in Kings County may apply for the restoration of taxes on personal property collected for State purposes within the last five years, and amounting in the aggregate to over $1,000,000. As applied to the Edison Company, who made the application, it is stated that by this decision the city will have to refund all the taxes collected from this company during the last five years in the manner indicated.

OPPOSITION TO THE OPEN-CONDUIT RAILWAY.—On Oct. 11 a notice was served on the Deputy Commissioner of Public Works, stating that a peremptory mandamus would be applied for, directing that the subways put down by the Metropolitan Street Railway Company be torn up and that the city prevent any more from being laid. The cause of this objection, which it is understood, emanates from a rival company, is the laying of large conduits for the drawing in of feeders. It is claimed that these subways have a capacity many times that needed for the feeding of the company's street railway system. Nothing has been paid the city for these franchises, which would cost, at the city's regular leasing price for subway space, an annual rental of $900,000. It is also claimed that should the entire system of the company be similarly fitted, the conduits, if leased, would be worth $3,000,000 annually to the city. The petitioner claims that the company has a right under its charter only to lay sufficient conduits for its immediate need. If this is true, some further liberties should certainly be given the company in order that it should not be obliged to tear up the streets for every increase in its service. The petitioner also claims that the company is laying these conduits for the purpose of general light and power distribution, and for rental purposes generally. As the company's charter does not provide for such functions it would seem as though the city were amply protected against such action on the part of the company.

SOME LARGE INDEPENDENT TELEPHONE EXCHANGES are soon to be constructed in the vicinity of New York. Mr. James E. Keelyn reports that the Western Telephone Construction Company, of which he is president, has recently taken contracts for a number of very large equipments. Among them may be noted those at Wilmington, Del., where a switchboard of 1200 capacity and 1000 telephones are now being installed, the station in which they are placed having an ultimate capacity of over 2000 telephones; the fine

plant for Newark and the Oranges, N. J., with 6000 stations and switchboard capacity to correspond, this plant having now in operation 1200 instruments, and in its full growth to be the largest opponent of the American Bell Company in the United States; the Paterson, Passaic & Suburban Company's exchange in Paterson, N. J., with 1000 instruments, of which 300 are now in operation; Chester, Pa., 400 instruments; Jersey City, Hoboken & Harrison, N. J., with 5000 instruments, the contract in this case calling for 12,000 telephones in Essex, Hudson, Mercer and Union Counties, N. J. The effect of the installation of these exchanges will be the working of the largest independent telephone system yet undertaken or constructed in any part of the world in the immediate suburbs of New York, lying on the other side of the North River. The work of installation is progressing as rapidly as the large capacities of the Western Telephone Construction Company's factory will permit, and goods are being shipped daily to the various exchanges listed above.

THE METROPOLITAN STREET RAILWAY COMPANY has received a lot of about 100 new car bodies to be used on Madison Avenue and other lines, which are now being reconstructed as underground trolley roads. The new cars were made by the John Stephenson Company and the J. G. Brill Company, the Stephenson cars being placed on Peckham trucks and the Brill cars on Brill trucks. The cars are being delivered to the Metropolitan Company's car barns at Lenox Avenue and 146th Street, where they are fitted with their electrical equipments. The new cars are substantially the same as those now used on the existing cable and electric lines of the company. Each car is provided with several push-buttons, so that the seated passengers may attract the attention of the conductor when they desire to alight. Some of the new cars are already in commission on the Lenox Avenue line, and attract considerable attention by their easy motion. One of them is equipped with a fender of new design, which is being tested. The fender does not present a very handsome appearance, but if it accomplishes the object for which fenders are designed, its hideousness will no doubt be overlooked. The company is now engaged in laying the yokes on the Eighth Avenue line, from 116th Street up to the northern terminus of the road. The work is being prosecuted with considerable vigor, and in order that it may be carried out with the least possible delay, the horse-car traffic on this section of the line has been stopped. The company is laying some new feeders along the Lenox Avenue line. They are laid in tubes buried alongside and outside of the downtown track. They were placed on the outside because there is no concrete there to break up and remove, and for this reason it was deemed to be easier to lay the conduits in this way, rather than between the tracks, where a bed of concrete is laid.

EXHIBITS AT THE AMERICAN INSTITUTE FAIR.—There are several electrical and kindred exhibits at the American Institute Fair, which is now in progress at Madison Square Garden in this city. The Gordon-Burnham Battery Company makes quite a display of its well-known cells, as well as the Law battery. It occupies a space enclosed with an iron railing, at the front of which is a diamond-shaped pyramid with steps. On these steps are displayed a line of Gordon-Burnham batteries and the Law batteries of all sizes. In a showcase are exhibited small fan motors, electro-medical batteries, a Weston milliammeter and a Weston voltmeter, switches, cauteries, small plunge batteries, etc. The Garvin Machine Company occupies a good-sized space, also enclosed by an iron railing. It has an exhibit of fourteen machines, comprising lathes, shapers, screw and milling machines, drill presses, tappers, twist and cutter grinders. Messrs. H. B. Coho & Co. have an attractive exhibit. They show an Eddy direct-current generator, type "M," of a capacity of 5.6-kw belt-driven by a 9-hp Otto gas engine. This combination supplies current for the illumination of the firm's space, which is effected by a row of incandescent lamps run overhead on all four sides of the exhibition space. There are also five Pioneer enclosed-arc lamps of various designs, including plain and ornamental lamps. The coverings have been entirely removed from one of the lamps, in order to show the mechanism and the simplicity of construction. The firm also shows a 5-hp Eddy automatic, 220-volt, type "G," motor, which is of the new 1897 design. The exhibit includes a small switchboard from which the lighting is controlled. The board is completely fitted out with switches and instruments. There are also three other Otto gas engines of different types; one is a 25-hp horizontal machine; another is an upright two-cylinder marine engine of 22 horse-power and the third is a single cylinder marine engine of 3¼ horse-power. The Waring Electric Cutter Company, New York City, shows the practical operation of its electric cloth cutters. The Ball & Wood Company has a simple 120-hp engine in the machinery hall, which supplies all of the power used at the fair. This engine is fitted with the new type governor, and self-oiling devices. It is belted to the shafting overhead, and runs at a speed of 275 revolutions. A 3-hp Crocker-Wheeler motor is used for the purpose of driving the skeleton of a "Century" printing press. The object of this exhibit is to show the easy to-and-fro motion of the platen of the press. Messrs. Watson & Stillman, New York City, have a line of hydraulic presses, jacks, etc. Mr. George Kirkegaard brings to public notice his electrical rat-trap, which was briefly referred to in a recent issue of THE ELECTRICAL WORLD. There are two of these traps. One of them is connected up with one cell of O. K. dry battery, and its operation exemplified. The rat question is one of that concerns a great many people and, in consequence, these traps are attracting considerable attention, as they are claimed to be infallible in operation and successful in the object for which they are made.

PHILADELPHIA NOTES.

Branch Office of THE ELECTRICAL WORLD,
929 Chestnut Street,
PHILADELPHIA, Pa., Oct. 12, 1897.

THE ELECTRICAL BUREAU has sent to the Councils its estimate for the maintenance of the service for 1898. The amount recommended to be appropriated for this purpose is $1,042,004, as against $979,180. The increase is for general extensions.

MR. JAMES I. AYER, of the Electric Heating Corporation, Boston, has been in Philadelphia for a week looking after some orders for heaters, and has secured for his company contracts for a large number of car heaters and other electric-heating devices.

BUFFALO NOTES.

BUFFALO, N. Y., October 11, 1897.

THE GENERAL ELECTRIC COMPANY has increased its output at the Elk Street lighting station, and is now prepared to furnish the Great Northern elevator with its full quota of 1000 horse-power, until the Niagara tunnel power is ready for delivery.

THE BUFFALO TRACTION COMPANY opened its new line last week and cars are now in daily operation. The road is over 15 miles in length. A fare of 4 cents is charged, that is, a rebate check of 1 cent is given for every 5 cent fare. In case a transfer to another road is given a 5-cent fare is charged, It is expected that this arrangement will bring the general fare down to 4 cents.

THE BUFFALO, HAMBURG & AURORA ELECTRIC RAILWAY COMPANY has applied for the privilege of laying its tracks in the village of Hamburg, 12 miles south of Buffalo, and is making the final arrangements to carry on the work, which will be taken up as soon as a permit is obtained. Mr. U. L. Upson, of Orchard Park, has been appointed general manager of the company.

THE SCHOELKOPF HYDRAULIC COMPANY, of Niagara Falls, whose headquarters are in Buffalo, is now engaged in selling the second installment of its power. When the power house was planned to take the water of the canal at the bottom of the gorge below the flour mills, only turbines enough for generating 8000 horse-power were installed. This amount was soon disposed of for use in the immediate vicinity of the power house, and now the second block, consisting of 12,000 horse-power, is being sold. A third quantity, also of 12,000 horse-power, will be provided. The plan of placing the dynamos at the end of the shafts of horizontal turbines at the bottom of the gorge and transmitting the power by wire instead of by shafting, is the basis of a claim made by the company that it can generate power cheaper than the Niagara Falls Power Company can.

PITTSBURG NOTES.

PITTSBURG, Pa., October 11, 1897.

TROLLEY LINE EXTENSION IN WESTMORELAND COUNTY.—The supervisors of Hempfield Township have given the Sadler-Myers street railway syndicate the rights of way required for an extension of its line toward the coke regions. The proposed road is to connect with the Greensburg and Hempfield line in South Greensburg, and will eventually extend, it is said, as far as Mount Pleasant. It will form a part of the system belonging to the Greensburg, Jeannette & Pittsburg Company.

CHARTER FOR A NEW STREET RAILWAY COMPANY.—A charter has been issued by the State Department at Harrisburg to the East End Passenger Railway Company, of McKeesport, with a capital stock of $6000. The line will be 1 mile long, running from the city boundary of McKeesport to the Driving Park in Versailles Township. John K. Skelly, of McKeesport, is president of the company, and the directors are W. E. Hartman, John R. Christy and R. C. Rankin, of McKeesport, and William Beal, of Pittsburg.

STREET-CAR MAIL SERVICE TO BE EXTENDED.—Several years ago a mail route was established on the lines of the Duquesne Traction Company, and ever since then the electric cars have been regularly utilized for carrying the mails between the Pittsburg Post Office and the various branch offices in the East End. The announcement is now made that a trolley-car collection service will be established immediately. The Consolidated Traction Company has ordered two special cars that will be used exclusively for this purpose. They will run out Fifth Avenue or Forbes Street to the East End, returning to the Post Office by way of Penn Avenue. Along the route, at intervals of four or five blocks, large collection boxes will be placed. Letters may be posted in these boxes, and they will also be used by the mail carriers as depositories for the mail collected from the smaller boxes on the side streets. Hourly trips will be made by the mail cars, which will collect the contents of the large boxes and convey it to the main Post Office. A great deal of work will thus be taken from the carriers, while the benefit to the public in quicker and better mail service will be very marked.

NEW REGULATIONS AFFECTING ISOLATED ELECTRIC PLANTS.—An ordinance that has caused a good deal of discussion has been introduced in Pittsburg Councils. It provides that all persons desiring to install wires for the conveyance of electricity, either overhead or underground, in the streets, must first secure a permit from the Department of Public Works. A plan showing the location and route of the proposed line must be filed with the department, and the work must be done under the supervision of the city inspectors. The ordinance is aimed primarily at the owners of isolated plants in the large buildings, many of whom have made arrangements for using surplus power to supply neighboring premises with current for light and power. Wires have been run across streets and alleys for this purpose, and since these cases do not come under the general ordinances controlling the installation of conductors by the light, power, telephone and telegraph companies, the city authorities have no control over them. It has been asserted that the object of the ordinance is to prevent the isolated plants from competing with the Allegheny County Light Company in the sale of light and power. The Director of the Department of Public Works denies this, and says that the ordinance is simply a measure to prevent people from running wires when and where they please, regardless of public safety.

Cleveland Notes.

CLEVELAND, Ohio, Oct. 9, 1897.

THE LORAIN & CLEVELAND ELECTRIC RAILROAD, the new suburban line, carried its first passengers Wednesday, October 6, and is now open for business. Trial trips have been run at intervals since last Friday. The scheduled rate of speed is 35 miles per hour, but Tuesday on a trial trip one motor averaged 52 miles, and when pressed to the limit covered track at the rate of 55 miles per hour.

DIVIDENDS.—The Board of Directors of the Big Consolidated declared a dividend of ¾ to 1 per cent. at the last meeting. The net earnings of the road for August were $49,820, as against $57,860 for the same period of last year. The gross earnings of the year, however, show an increase over last year. The quarterly dividend of ¾ to 1 per cent. was declared by the Little Consolidated directors at a meeting held on Monday.

STREET CAR-FARE FIGHT.—The question of a reduction of fares on the two city roads, which has been engrossing most of the time of the City Council at its meetings for the past three months, is still being carried on with undiminished vigor. At the Council meeting last Monday the Hopkins 3-cent fare ordinance was lost by an adverse vote. The question is to be brought up again at the Council meeting next Monday. At a joint committee meeting of the street railroad men and members of the City Council held some few days ago, the railroad companies offered to sell six tickets for a quarter, give universal transfers, and pay 5 per cent. of their gross receipts to the city, conditionally upon their being granted a twenty-five-year franchise, and pay no additional tax to the city for paving.

A GIGANTIC LOCAL PROJECT.—Plans which have been developing for a year past have at last come to a head in a well-defined proposition to connect Cleveland and Cincinnati by an electric railroad. Papers of incorporation have just been issued to the Cleveland, Medina & Southern Electric Railway Company. The incorporators are F. C. Goodman, Joseph W. Roof, W. P. Hackney, A. R. Gibson, George A. McKay, Francis McMillen and Joseph H. Storer. The capital stock is placed at $750,000. Work is to be commenced at an early date on the road between Cleveland and Chippewa Lake. The directors promise that this branch will be in operation early in the spring. The road will pass through the following countries: Cuyahoga, Medina, Wayne, Ashland, Richland, Knox, Licking, Franklin, Madison, Fayette, Greene, Warren, Clermont and Hamilton.

General News.

The Telegraph and Telephone.

FULTON, N. Y.—The New York State Telephone Company has commenced the work of installing its plant at this place.

PLYMOUTH, ILL.—The Western Illinois Telephone Company is constructing a telephone line between Carthage and Mountain Green.

ORION, ILL.—It is stated that work will be commenced at once on the construction of the new telephone line from Cable and Sherrard to Orion.

TOPEKA, KAN.—Mr. W. Dilworth, of Beloit, has secured the franchise for a telephone plant at that place. It is expected that the plant will start with at least sixty telephones.

MILWAUKEE, WIS.—The Milwaukee Telephone Exchange has provided for the distribution of music over its lines from the Schlitz Palm Garden. All subscribers with long-distance telephones can be connected with the Garden and hear the concert at their own homes.

COLUMBUS, OHIO.—The Mount Vernon Telephone Company has purchased all the lines of the Peoples Telephone Company in the county, extending also to Utica in Licking County, Butler in Richmond County and Chesterville in Morrow County. The purchase includes about 110 miles of line, with numerous stations.

MINNEAPOLIS, MINN.—The long-distance telephone lines, which were recently completed through from the Eastern system to this point, will soon be extended by the addition of a line to Duluth, Minn. This line will undoubtedly carry considerable business, because of the enormous lake traffic which starts from Duluth for Eastern cities and the large mining concerns which have offices in Duluth.

MEMPHIS, TENN.—The Cumberland Telephone & Telegraph Company has been served with an alternative mandamus requiring it to furnish W. T. Avery, a citizen of this place, with a telephone at his residence, at the rate of 50 cents per month. This is in the nature of a test case, and it involves the construction of Section XI., of Chapter 66, of the Acts of 1885, relative to the charges to be exacted for telephone service by telephone companies.

FRANKFORT, IND.—The telephone rate war in this city is at an end. The Home Company has increased its charges for business and residence instruments 25 cents a month, which increase will probably be met by the Bell Company. The latter company is now furnishing instruments at the rate of 40 cents to residences and 80 cents to business houses, and the cheap service which the residents of this place have been enjoying is now a thing of the past.

Electric Light and Power.

HAMMONDSPORT, N. Y.—At an election a few days ago the proposition to establish an electric-light plant in this place was defeated.

WARWICK, N. Y.—J. H. Sharpe, general manager of the electric-light company at Liberty, proposes to erect an electric-light plant at this place.

ST. PAUL, MINN.—The City Clerk has been instructed to advertise for bids for the erection of an electric-light plant, with a capacity of 500 arc lights.

SALT LAKE CITY, UTAH.—On September 29 the line of the Union Light & Power Company, between Salt Lake City and Ogden, was tested for the first time. A current of 2000 volts was first turned on, and later in the afternoon the full pressure of 15,000 volts generated at Ogden Canon was applied to the line, with satisfactory results.

BALTIMORE, MD.—The United States Electric Power & Light Company, of Baltimore City, has been reorganized under the name of the Northern Electric Company. The plant and business of the old company will remain intact, and business will be carried on as usual. The capital stock of the Northern Electric Company is $400,000. A mortgage has been given to the Guaranty Security Trust & Deposit Company, of Baltimore, to secure an issue of $100,000 of the company's bonds. Mr. Frank J. Morrison has been elected general manager of the company, and in order to accept this position he has resigned that of superintendent of the Maryland Electric Company.

The Electric Railway.

BOUND BROOK, N. J.—The Brunswick Traction Company has been granted a franchise for an electric railway in this city.

NORTH BROOKFIELD, MASS.—The Warren, Brookfield & Spencer Railroad has asked for a franchise to build a road to this place.

WESTFIELD, N. J.—The Westfield & Elizabeth Street Railway Company has petitioned the Township Committee for permission to construct a street railway in the city.

RED BANK, N. J.—The Red Bank, Atlantic Highlands & Long Branch Electric Railway Company is surveying for a trolley line to Fair Haven and Oceanic. A. G. Greenberg, president.

MOUNT VERNON, N. Y.—The Union Railway Company intends to extend its line from this place to Bartow and City Island. The New York, Elmsford & White Plains Railway Company also announces that it will construct a trolley line as soon as practicable from White Plains, N. Y., to Mamaroneck.

MILWAUKEE, WIS.—The Milwaukee Electric Railway & Light Company has decided to build its own cars hereafter, and the repair shops of the company on Kinnickinic Avenue will be equipped for that purpose. The company proposes also to place on the lines at night a repair car to take the place of the horse patrol wagon now used.

Personal Notes.

MR. W. J. WALLACE, of the firm of Goldmark & Wallace, New York City, and formerly of Wallace & Sons, was, on September 21, married to Miss Grace A. Gibson.

MR. J. H. ASTRUCK informs us that he severed his relations with the Electric Arc Light Company, of this city, on October 11. Any communications can reach him at No. 15 Whitehall Street, Room 33.

MR. LUDWIG HOMMEL, of the staff of electrical engineers of the Standard Underground Cable Company, sailed from New York a few days ago for Costa Rica, to take charge of the construction of the new telephone and electric-light plant at San Jose City, the capital of that country.

MR. THOMAS LOFTIN JOHNSON.—The active part which Mr. Johnson is taking in the Greater New York Mayoralty contest is bringing his career in the electric-railway field prominently to the front. Mr. Johnson is a great admirer and warm friend of one of the candidates, and he takes such an interest in the candidacy of his friend that he is devoting a great deal of his energy to the cause. The career of Mr. Johnson, as brought out by his present publicity, is quite interesting. His business life began in the employ of the Central Passenger Railroad, of Louisville, Ky. In 1876 he obtained control of a street railway in Indianapolis. Three years later he bought a small line in Cleveland, and by energy and ability in a short time effected the consolidation of all the railroads in that city. In 1884 he formed the Johnson Company, of Johnstown, Pa., for the manufacture of steel rails. Mr. Johnson was nominated for Congress in 1888, and was elected in 1890, and again in 1892. Mr. Johnson is said to employ 20,000 hands in his various enterprises. Besides his ownership in the roads above mentioned, he has large street railway interests in Detroit, Brooklyn, Chicago and Boston. Although probably a multi-millionaire, Mr. Johnson takes the deepest interest in all questions of an altruistic nature and all problems of social reform, and the betterment of the condition of the laboring classes.

Trade and Industrial Notes.

THE UTICA ELECTRICAL MANUFACTURING & SUPPLY COMPANY, Utica, N. Y., has been awarded the contract to establish an electric-light plant at the Rome Tea-Kettle Works, Rome, N. Y.

A WELL ILLUSTRATED CATALOGUE has just been issued by Mr. M. T. Davidson, 133 Liberty Street, New York City, the pump manufacturer. Copies of this catalogue may be had on application.

THE DAYLIGHT DESK LAMP is the name of a lamp manufactured by William Schwarzwaelder & Co., 82 Fulton Street, New York City. From reports it is evident that this lamp is giving excellent satisfaction. About fifty of them are in use in the Jersey City Hall.

THE BUCKEYE ELECTRICAL REPAIR WORKS, Columbus, Ohio, has just shipped twelve 15-hp armatures to Butte, Mont. This company reports a decided improvement in business during the past eight weeks, and is compelled to run its works night and day.

THE J. I. CASE THRESHING MACHINE COMPANY, Racine, Wis., has been sold to a syndicate. The purchase price is said to be $2,000,000. The

plant and business of the company have been turned over to the new owners. The names of those composing the syndicate have not been made public.

A LARGE LINE OF LATHES, shapers, drill presses, etc., has been sold to the A. Borsig Company, of Germany, by the Davis & Egan Machine Tool Company, Cincinnati, Ohio, through its Berlin office. The Borsig Company is one of the largest locomotive works in Europe, employing over 8000 men.

APPRECIATION OF WIRT BRUSHES.—A unique scrapbook containing letters received during the last seven years has been kept by Mr. Charles Wirt, 1028 Filbert Street, Philadelphia. Some of these are humorous, some are samples of "English as she is spoke," but all are emphatic in praise of the Wirt brush.

EXHIBIT OF THE OHIO BRASS COMPANY.—The Ohio Brass Company will exhibit its appliances for street railway work at the Niagara Falls convention next week. The company will distribute a unique souvenir to its friends, which can be obtained by those who do not attend the convention on application to the company.

AN ORDER FROM THE KRUPP WORKS at Essen, Germany, for a number of machine tools, has been received by the Davis & Egan Machine Tool Company, Cincinnati, Ohio, through its office at Dusseldorf, Germany. The introduction of these goods into the immense Krupp factory speaks well for this company's products.

MR. L. E. RHODES, formerly connected with the L. E. Rhodes Company, Hartford, Conn., and prior to that time with the Pratt & Whitney Company, has become associated with the Davis & Egan Machine Tool Company, Cincinnati, Ohio. He will have charge of the department in which are manufactured Lincoln millers, hand millers, etc.

THE PHOENIX ELECTRIC TELEPHONE COMPANY is the new name adopted by the Phoenix Interior Telephone Company at 93 Washington Street, New York City. The word "Interior" in the old title was a misnomer, as the company manufactures telephones for all services, and for this reason it was deemed best to drop the word, which had a contracted meaning.

THE KOCH WOVEN-WIRE DYNAMO BRUSH, without tubes, has been reduced in price by Messrs. Goldmark & Wallace, New York, who are the manufacturers' agents for these brushes. The reduction in price applies only to the brushes without tubes. The object of the tubes in the Koch brushes is to stiffen the brushes sufficiently to allow them to be used without guards.

MR. S. B. CONDIT, of L. A. Chase & Co., Boston, has been in New York and Philadelphia during the week on business. Mr. Condit reports the receipt of some large orders for the Elden circuit breakers, manufactured by his company. The Edison Illuminating Company of Baltimore has decided to equip all its alternators with these instruments. Several large export orders have also been recently received.

SALES AGENCIES have recently been established by the C & C Electric Company, of New York City, in Pittsburg and Louisville. The Pittsburg sales agents are L. W. Woolston & Co., who have opened offices in the Vandergrift Building, while the Louisville office, in the Columbia Building, will be in charge of Mr. J. H. Cochran, an engineer and contractor, who has for several years done the bulk of electrical work in and about Louisville.

A DRAY LOAD OF DRY BATTERIES was shipped from Painesville, Ohio, the other day. The Burnley Battery & Manufacturing Company, of that city, looks upon such an event as an evidence of a stirring demand for Burnley dry batteries and an appreciation by the trade of the quality of these goods. Since the price of this battery was reduced the company states that orders have been increasing every day. This concern turns out none but the best.

VERTICAL MILLING MACHINES, in two sizes, have just been put upon the market by the Garvin Machine Company, of New York City. They are entirely new and improved in every respect. In the company's new catalogue are shown illustrations of the many machines made by this company. They comprise many styles and sizes of screw and milling machines, tappers, die slotters and sinkers, screw slotters, gear cutters, cutter grinders, lathes, planers, shapers, etc., etc.

A CONTRACT for furnishing and erecting the structural ironwork of floor and roof of a barn for the Connecticut Hospital for the Insane, at Middletown, Conn., has been given to the Berlin Iron Bridge Company, East Berlin, Conn. The building is 50 feet wide, and about 200 feet long. The floor of the barn proper over the cellar is supported by steel beams and brick arches. The roof and interior supports of the stalls are of steel. Every precaution has been taken to make this new barn fireproof, and to make it an up-to-date, permanent, handy and economical structure.

"FULL MEASURE AND GOOD QUALITY" is the title of a very beautifully colored half-tone engraving, recently sent out by the Western Electric Company, New York and Chicago, representing a box of strawberries turned over on its side, with the berries spilled and scattered over a napkin. The coloring is very natural, and artistically executed. At the back of the card are given illustrations of four styles of the Western Electric Company's enclosed arc lamps for constant potential direct-current circuits.

PROSPERITY AND ENCLOSED-ARC LAMPS.—Judging from the orders that have been placed with the Electric Arc Light Company, makers of the "Pioneer" enclosed arc lamps, the indications are that there is a special movement among dry goods people in anticipation of the conceded revival in trade. Among the company's New York orders it reports just having closed with the dry goods firm of Messrs. H. O'Neill & Co., Sixth Avenue and Twentieth Street, for the equipment of their establishment with "Pioneer" lamps.

ELECTRICALLY PROPELLED VEHICLES of various designs constitute the subject of a little catalogue entitled "The Twentieth Century Movement," which has just been issued by the American Electric Vehicle Company, Chicago. The various styles of electrical vehicles made by this company are illustrated and specifications of each are given. The vehicles present a handsome appearance, and those intended for private and pleasure purposes have the appearance of being well designed, both mechanically and aesthetically. Two styles of business wagons are also illustrated.

LARGE GEAR CUTTERS.—The Blake Steam Pump Works, Boston, Mass., has added the largest Eberhardt's automatic gear cutter ever built, for cutting spur gearing of the coarsest pitches, 100 feet by 20 feet face, weighing about eight tons. Gears of many tons' weight can be put into the machine and taken out without changing any adjustments. The machine, it is stated, will take larger diameters of cutters and coarser pitches than any machine ever built. It possesses improvements never before put upon the market, and is supplied with cutters specially adapted for automatic machines.

IN RE GASKETS.—The Garlock Packing Company, Palmyra, N. Y., announces that it is now manufacturing a full line of cut gaskets for boiler manholes and handholes; also for all other uses. The Garlock cut gaskets are of a high grade and said to be superior to any now on the market. They are manufactured in a number of grades to meet all demands of the trade, among which might be mentioned the Garlock gasket, the Economical gasket, and the Achilles gasket. Engineers who have, or are experiencing trouble with leaky manhole or handhole plates would do well to try the Garlock gasket.

ASSEMBLED MOTOR COMMUTATORS.—The fact that street railway people can order and receive by return freight perfectly constructed motor commutators for replacing those worn out on their motors will certainly be appreciated. The Miller-Knoblock Company, South Bend, Ind., by using an improved process of making commutators, which is the invention of Mr. A. W. Morrell, an electrical and mechanical expert, is shipping commutators that are guaranteed to be longer-lived and to give better satisfaction to the end than commutators as usually constructed. The company solicits orders for commutators with the understanding that if not in every way acceptable that they are to be returned.

THE MICA INSULATOR COMPANY, of New York and Chicago, will make a display of a full line of its micanite insulating specialties at the Niagara Falls convention of the American Street Railway Association. During the past year the company has added several new lines of insulating materials to its already extensive list, two of which may be mentioned—flexible micanite plate and the "M. I. C." insulating compound. "Micanite" and "Empire" cloths and papers, together with micanite plates for commutator segments, will be attractively displayed. Mr. Franklin Brooks, vice-president of the company, and Mr. Charles E. Coleman, manager of the Chicago branch, will be in attendance.

MICA EXHIBIT AT THE NIAGARA CONVENTION.—Eugene Munsell & Co., New York and Chicago, miners and importers of mica, will exhibit a line of India and amber mica at the convention of the American Street Railway Association, which will be held at Niagara Falls next week. The exhibit will be in connection with that of the Mica Insulator Company, and will consist of mica in the sheet, as it comes from the mines; mica segments and a variety of cut sizes as used for the electrical trades generally. A souvenir "Mica Mine Puzzle" will be given to callers at the booth. Mr. Franklin Brooks, of the New York house, and Mr. Charles E. Coleman, the Western manager, will be in attendance.

THE GENERAL ELECTRIC COMPANY will make a representative exhibit at the convention of the American Street Railway Association, which will be held at Niagara Falls next week. The moving part will consist of motors mounted on McGuire, Brill and Peckham trucks. The apparatus showing the operation of the magnetic blow-out will comprise four types of automatic circuit breakers, arranged to be shown breaking currents up to 200 amperes. The H. D. lightning arrester, also fitted with the magnetic blow-out device, will be shown discharging under high-potential current. Ten of the new G. E. railway arc lamps will illuminate the space. A wattmeter exhibit, showing the street-car meter and station output meter especially, will be made. The headquarters of the General Electric Company will be at the International Hotel, where its interests will be cared for by twenty-two or more representatives.

IMPERIAL PORCELAIN.—For high-tension electrical transmission it has been found that porcelain makes the only satisfactory line insulator. However, the ordinary porcelain will not serve for this purpose at all. Porcelain used for other than electrical purposes consists of a porous, absorptive material, covered with a white, smooth glazed surface. If the insulators are made of this, the surface skin gives high insulating properties, but the slightest flaw or crevice in this skin will allow the high-tension current to reach the interior, which being absorptive, is more or less moist, and carries the current to the pin. It is absolutely necessary for high-potential work to have insulators that are glazed or vitrified through their entire mass. Such porcelain is made by the Imperial Porcelain Works, of Trenton, N. J. A broken piece of their insulators shows its homogeneous nature, and a test of red ink shows its non-absorptive qualities.

ELECTRIC POWER TRANSMISSION IN JAPAN.—Mr. Campbell Scott, the general sales agent of the C & C Electric Company, New York, advises us that his company has just received another large order from Japan for a complete equipment of generators and motors of its latest types to be used in a power transmission system for the Hankaku Railway Company's shops at Osaka. In this plant some 100 horse-power in motors is to be installed at the present time, but in the near future the capacity is to be very largely increased. Mr. Scott also reports that his company has secured contracts recently for several domestic electric-power transmission equipments, some of them of considerable size, besides many other orders for all sizes of dynamos and motors of its latest types. The company's extensive works at Garwood, N. J., are running with a large night shift in an endeavor to catch up with the rapidly increasing orders.

A SUCCESSFUL TRIP AROUND THE WORLD.—The Pierce & Miller Engineering Company, New York City, reports a strongly marked increase along all its lines of business, following the return of its president, Mr. F. M. Pierce, from his tour around the world, during which he made many valuable connections. From observations he made while abroad, he decided

that America would do a large European business in furnishing equipments for electric tramways, and to accommodate this, and the rapidly increasing home trade, a large increase in this company's engineering and selling force has been drawn from England and Ireland. Mr. Pierce has made strong financial connections in London and New York, which enables his company to "finance" electric railway and other first-class enterprises. This company reports work in hand as follows: One 300, three 1200, three 800 horse-power, and several hundred horse-power in small engines, and one complete railway power plant. It is now handling the Rice-Sargent engine for large work, and the "Standard" Ball of Erie for the smaller high and medium speed electric purposes.

ELECTRICAL AND MECHANICAL COURSES AT THE UNIVERSITY OF NOTRE DAME.—It is not many years since the teaching of the engineering sciences was limited to the purely scientific schools. Of late years, however, the demand has been so general for engineering education that most of the universities and many other schools have added courses in these branches. Among the institutions which have lately made this addition is the University of Notre Dame, at Notre Dame, Ind. Recognizing the fact that these studies require a thorough laboratory equipment, the school has installed apparatus which is remarkable considering the infancy of the new courses. One building called Science Hall is given over to the departments of chemistry, physics and electrical engineering. The dynamo laboratory is equipped with a 40-hp high-speed engine, an Edison 110-volt generator, a T-H arc-light machine, and several smaller machines of various types, including a high-frequency alternator. A complete set of measuring instruments, converters, resistances, etc., are also provided. Another room contains a complete electro-plating outfit, including engine, dynamo, tanks, buffer, etc. Besides these plants there is the regular university lighting plant located in the main power house, giving practice in dynamo and repair work. The courses in engineering occupy four yearstime, and are laid out with the idea of giving a thorough technical education with which is combined as much liberal instruction as possible.

ELECTRIC-MOTOR REGULATORS.—The October 1 edition of the catalogue of the Mason Regulator Company, Boston, Mass., contains much that is of interest to electrical men. The Mason rheostat controller is especially designed for governing electric motors driving pumps for hydraulic elevators. The regulator works on the standard Mason relay principle, by which the water pressure controls a valve which admits water below or above a piston operating the rheostat. The use of this small auxiliary valve makes the instrument sensitive to small changes of pressure, and the driving force being obtained by a separate piston makes it available for controlling the heaviest rheostats. The instrument is also available for controlling motors driving air-brake pumps. Among the other things listed in this catalogue is the Mason hydraulic damper regulator. In this, as in the rheostat regulator, and auxiliary valve and power cylinder are used, but the control is differential, so that the position of the dampers does not tend to race from extreme to extreme, but varies with the steam pressure. The Mason Company also makes a governor for direct-acting steam pumps. This governor holds the speed of the pump constant in spite of variations of steam or water pressure. In case the pump tends to race the governor shuts off the steam, and vice versa. The governor is, therefore, to the plunger pump what the centrifugal governor is to the steam engine. The Mason by-pass, or water-relief valve, is adapted for use with motor-driven hydraulic-elevator service. In many cases it is desirable to keep the motor running at full speed, and regulate the water output by a by-pass. This method is not as inefficient as it would appear at first sight, as when the by-pass is open the motor is running light and consuming very little power. Besides these instruments, which are of special interest to the electrical profession, the Mason Regulator Company makes many other regulating devices, which are invaluable in special work.

THE HAMBURG WORKS of the Standard Paint Company, of New York City, will be ready next month to accept and deliver orders for P. & B. products used in the electrical industries in Europe. It is not generally known that the Standard Paint Company has established a factory on European territory, but owing to the fact that the company's products have been in use in various parts of Europe for the past six years or more, and that the high tariff existing in Germany seriously interfered with the natural increase of the business, it was decided by the company last January to make its products readily available to the European market by erecting a factory somewhere on the Continent. It was finally decided to establish the works in the city of Hamburg, Germany. The site selected for the purpose is most eligibly situated on the banks of the River Elbe, making it possible to receive all raw products and to ship all finished goods by water to any part of the world, without any other handling than that of water transportation, pure and simple. The company has been engaged for some months past in the work of building the new Hamburg factory. From this new establishment will be turned out P. & B. electrical compounds, P. & B. tape, P. & B. armature varnish, as well as some grades of the P. & B. insulating paper, all of which have been extensively used in various parts of Europe for the past few years. The length of time necessary for orders dispatched from this country was also a drawback in the company's endeavors to satisfy its foreign customers, and this was also one of the reasons which finally led the company to establish a factory in Europe. The sales office of the company at Hamburg is in charge of the firm of Messrs. Allut, Noodt & Meyer. The business of the factory will be confined to European markets. Mr. Robert W. Blackwell, 39 Victoria Street, Westminster, London, S. W., is the representative of the company in Great Britain, and for France, Belgium, Holland and the colonies.

THE CLONBROCK STEAM BOILER COMPANY, Brooklyn, N. Y., announces a very bright prospect ahead for business. It has many orders to be delivered at once. It has also secured the entire power plant required by the Trans-Mississippi & International Exposition Company, at Omaha, Neb. Among the company's most recent sales are the following: The Salt Lake County Light, Heat, Power & Cold Storage Company, Salt Lake City, Utah, four 250-hp boilers; Queen Dyeing Company, Providence, R. I., one 400-hp boiler; the United Electric Light & Power Company, New York, three 600-hp boilers; Providence Gas Company, Providence, R. I., one 250-hp boiler, second order; the Converse Building, Boston, Mass., two 125-hp boilers; the Roxbury Gas Company, Roxbury, Mass., two 50-hp boilers; the Economy Light, Heat & Power Company, Scranton, Pa., two 300-hp boilers; People's Light & Power Company, Jersey City, N. J., one 600-hp boiler, fourth order; Whitney Factory, North Attleboro, Mass., one 80-hp boiler; Brazer Building, Boston, Mass., two 90-hp boilers; New Jersey & Pennsylvania Concentrating Works, Edison, N. J., two 350-hp boilers, third order; Riverside Iron Works, Wheeling, W. Va., two 550-hp boilers, twelfth order; Tennessee Centennial Exposition Company, Nashville, Tenn., 2500 horse-power; Providence Gas Company, Providence, R. I., one 200-hp boiler; the Crescent Insulated Wire & Cable Company, Trenton, N. J., one 200-hp boiler; Jacksonville Electric Light Company, Jacksonville, Fla., one 200-hp boiler; Jersey City, Hoboken & Rutherford Electric Railway Company, Rutherford, N. J., one 350-hp boiler, second order; George Watkinson & Co., Rubber Works, Philadelphia, Pa., one 300-hp boiler, second order; People's Light & Power Company, Orange, N. J., two 600-hp boilers; New York Steam Company, New York, two 1000-hp boilers; Hazleton Manufacturing Company, Hazleton, Pa., two 200-hp boilers; the American Manufacturing Company, Brooklyn, N. Y., one 500-hp boiler, second order; Mathieson Alkali Works, Saltville, Va., one 500-hp boiler, second order; Latimer & Fernandez, St. John, Porto Rico, one 250-hp boiler; Edison Electric Light Company, York, Pa., one 350-hp boiler.

Business Notices.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 67-71 Park Place, New York City.

LETTERS FROM FARMERS in South and North Dakota, relating their own personal experience in those States, have been published in pamphlet form by the Chicago, Milwaukee & St. Paul Railway, and as these letters are extremely interesting, and the pamphlet is finely illustrated, one copy will be sent to any address on receipt of 2-cent postage stamp. Apply to E. F. Richardson, General Agent Passenger Department, 381 Broadway, New York City.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED OCTOBER 5, 1897.
[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

591,002. ELECTRIC BELL-CHIMING APPARATUS; N. McMenamin, Trenton, N. J. App. filed Nov. 18, 1896. Means for ringing bells and for other purposes, comprising essentially a circuit-closer, an operating lever or key for tilting the said circuit closer to complete the circuit, and means to restore the circuit closer to its normally inactive position when released from the influence of the lever or key, combined with a bell-actuating lever adapted to be connected with the bell, a pole piece suspended from the bell-actuating lever, an electromagnet arranged adjacent to said pole piece, and electric conductors wired with the electromagnet, the circuit closer being arranged and operated to make and break the circuit between the said conductors.

591,009. AUTOMATIC FIRE ALARM; T. F. Robinson and F. Smith, Little Falls, N. Y. App. filed Feb. 1, 1897. In an automatic fire alarm, the combination, with the insulating base plate, being provided with a centrally located hollow portion, the forward end of said portion being reduced so as to form a square shoulder, two conductors, forming part of an electric-alarm system, extending into said hollow portion, a plunger slidably mounted in said hollow portion, said plunger being provided at its rear end with a piston having a longitudinal guiding surface and a conical-end portion, a spiral spring interposed between the piston and the said shoulder in the hollow portion of the base plate, the forward portion of the said plunger being reduced and terminating in a knob, a hole extending through the thick portion of the plunger adjacent to the reduced portion thereof, a pin capable of being destroyed when exposed to a predetermined temperature partly extending through said hole, said pin being provided with an enlarged portion or head, a staple or guide located on the front surface of the base plate, engaging said head of the pin.

591,010. AUTOMATIC-TEST CIRCUIT; L. G. Rowand, Camden, N. J. App. filed Dec. 22, 1896. A main circuit, a secondary circuit having a source of current supply independent of the main circuit's supply, said secondary circuit having separate branches, indicating devices in each branch and a switch in each branch, the switch of one branch being provided with a device tending to keep it closed, and the switch of the other branch with a device tending to keep it open, and electromagnet acting when energized, against both said devices.

591,011. TELEPHONE SYSTEM; A. W. Rose, New York, N. Y. App. filed Oct. 7, 1896. In a telephone system, the combination of a trame, an indicator having a stem sliding in said frame and insulated therefrom, a magnet having an armature to control said indicator, a back contact for said stem, circuit connections to said frame and said back contact, a plug having separate contacts for said frame and said stem, respectively, separate line connections to said frame and back contact, respectively, and sepa-

rate connections to the contacts of said plug, whereby upon application of said plug to said frame the connections to the plug are brought into circuit with said line connection.

591,024. DYNAMO-ELECTRIC MACHINE; M. E. Thomson, Ridgway, Pa. App. filed April 12, 1897. In a dynamo-electric machine, the combination of a coil of wire having a binding wrapper, as of cord, and studs projecting from the faces of the coil and having feet engaging under the wrapper.

591,026. ELECTRIC-ARC LAMP; C. S. Van Nuis, New Brunswick, N. J. App. filed May 1, 1896. In an arc lamp, the combination with the carbons, of an inclosing globe for the arc, having an aperture through which a carbon passes with a practically air-tight fit, and an adjustable and practically air-tight joint for said globe where the other carbon enters, and whereby the globe is free to adjust itself relative to the carbons while maintaining said last named joint air-tight.

591,071. ELECTRIC GAS-LIGHTING APPARATUS; A. L. Bogart, Jamaica, N. Y. App. filed Feb. 24, 1897. The combination in an electric gas-igniting apparatus, of a main gas-supply pipe, a by-pass, valves for independently controlling the main supply and by-pass, a flash ladder connected to the by-pass, an electric igniter, and means for operating the said igniter, and jets to be ignited by the flashlight.

591,092. FLEXIBLE METALLIC TUBE OR CONDUIT; H. H. Brooks, Medford, Mass. App. filed Aug. 21, 1897. A flexible tube or conduit having a lining composed of a strip of sheet metal provided with an insulating coating or surfacing and formed into a spiral.

591,100. ELECTRIC RAILWAY; J. C. Henry, Denver, Col. App. filed June 29, 1897. In an electric-railway system, the combination, with a plurality of electric-supply circuits, of a series of motors having their fields excited from one of said circuits by a circuit independent of the armature circuits, and variable connections between the supply circuits and the armatures of said motors.

591,104. INSULATOR FOR ELECTRIC WIRES; W. Roberts, Mobile, Ala. App. filed Nov. 3, 1896. A wire insulating and attaching device provided with a transverse opening or passage, a slot to admit the wire and a groove to receive the wire passed into said slot and opening, the said slot and grove being arranged at an angle to each other and in communication with the said transverse opening and the said groove being adapted to engage and retain the wire in such manner as to prevent turning or unscrewing of the device.

591,126. PLUG SWITCH; W. R. Cole, Detroit, Mich. App. filed March 11, 1897. In a plug switch, the combination of two parallel insulator plates apertured in line with each other, a spring-socket contact placed in each aperture and cars on said sockets extending between and clamped by said plates serving to hold said sockets in position out of contact with each other.

591,127. TELEPHONE-EXCHANGE SYSTEM; W. R. Cole, Detroit, Mich. App. filed April 28, 1897. The combination, with the main lines and terminal contacts therefor, arranged in groups of trunk-lines equal in number to the total number of main lines, and extending to all the groups, main and auxiliary annunciators for each of said main lines and their corresponding trunk lines, arranged at their respective main-line groups, said annunciators adapted in their operation to operate their auxiliary annunciators adapted when operated to break their operating electric circuits, means at each group for closing an electric circuit through any one of the trunk lines and its auxiliary annunciator when the latter is in its normal position a signal for indicating to the operator when said circuit is closed, and means for connecting any of the main-line contacts of each group with any of the trunk-line contacts.

591,143. HEAT DETECTOR; H. Ruetschi, Newark, N. J. App. filed March 25, 1897. A circuit closer comprising, in combination with an open frame, a fine metallic wire stretched in said frame, a pair of electrical contacts in said frame, and a spring in said frame, said spring having a perforated contact-end portion, through which said wire passes to normally force said spring out of contact with one of said electrical contacts on said frame.

591,160. ELECTRICAL APPARATUS FOR SURGICAL PURPOSES; W. E. Dow, Braintree, Mass. App. filed Aug. 16, 1897. In a rheostat, a resistance coil or helix; a contact piece in constant electrical engagement with the convolutions thereof, and means, acting upon rotation of said coil, to cause axial movement of the latter.

591,162. SPEED AND DIRECTION INDICATOR; B. A. Fiske, U. S. Navy. App. filed Feb. 24, 1896. The combination, in an electrically controlled direction indicator, with a direct-current responsive device or indicator, of a helix connected permanently in electrical circuit therewith, a soft-iron core whereon said helix is mounted, and a magnetic device having a plurality of dissimilar pole pieces mounted upon and adapted to be actuated by the movement of the indicated part to present said dissimilar pole pieces to the core in different predetermined orders corresponding to the direction of movement of said part, whereby actuating currents are generated in the indicator circuit.

591,179. ANNUNCIATOR; F. P. Stevens, Colorado Springs, Col. App. filed Oct. 13, 1896. In an annunciator, the combination of a slotted plate, an indicating plate having projections operating in the slot of the first-mentioned plate, an electromagnet having a projecting pole piece, a stop to engage with a projection of the indicating plate and hold it out of sight, and an armature connected with the said stop and recessed to receive the pole piece of the electromagnet.

591,182. ELECTRIC ARC LAMP; E. P. Warner and J. Oehring, Chicago, Ill. App. filed Aug. 10, 1896. In an arc lamp, the combination, with a flexible supporting ribbon of a wheel or pulley over which the ribbon passes, a vertically adjustable carbon carrier, suspended from one end of said ribbon, a weight suspended from the other end of said ribbon, an electrically operated clutch mechanism engaging the said ribbon, adapted to control its feeding movement and secure the adjustment of the same and means controlled by the movement of said ribbon for altering the circuits through the lamp.

591,192. MULTIPLE SWITCHBOARD FOR TELEPHONE EXCHANGES; W. S. Nash, Knoxville, Tenn. App. filed May 20, 1897. In multiple switchboards for telephone exchanges, the combination of the subscriber's telephone in electrical connection with corresponding line switches on several multiple boards of the exchange, each attached in a suitable manner to the frame of a corresponding spring jack, a test thimble to each of the spring jacks, spring switches, one end of each being in electrical engagement with the test thimble of a corresponding spring jack, and adapted to be operated by the insertion of a suitable switch plug through the thimble of the spring jack, means for electrically connecting the thimbles of corresponding spring jacks on the several multiple boards of the exchange, contact points in electrical connection with a suitable generator and adapted to electrically engage said spring switches when same are depressed, switch plugs insulated save at their extremities, one of said switch plugs being inserted through the test thimble of a spring jack in electrical connection with a corresponding spring switch, from which it is insulated, into electrical engagement with one of said contact points, a similar switch plug on a different multiple board of the exchange, a switch lever in electrical connection therewith, an arm on said switch lever, adapted when the switch lever is operated, in one direction, to engage a contact point in electrical engagement with the operator's head-'phone, and another arm on said switch lever, which, when said switch lever is operated in another direction, breaks its connection with the operator's telephone, to engage a contact point in the calling circuit, actuated by said generator and adapted when established, to ring up both subscribers whose lines are connected.

591,194. METHOD OF AND APPARATUS FOR MULTIPLE RATE-METERING FOR ELECTRIC CURRENTS; E. Oxley, Washington, D. C. App. filed Aug. 23, 1897. The method of metering the consumption of electric energy at different rates during different periods of time, which consists in inserting a definite resistance in the armature circuit of each one of a number of meters installed at a corresponding number of separate points of consumption, maintaining said resistance in said circuits during the period of consumption at a reduced charge, and withdrawing said resistance during the period of consumption at full rate.

591,195. METHOD OF AND APPARATUS FOR MULTIPLE RATE-METERING FOR ELECTRICAL CURRENTS; E. Oxley, Washington, D. C. App. filed Aug. 23, 1897. The method of metering electrical energy consumed during different periods of a day and at different rates, which consists in varying the speed of the registering mechanism at a number of consumers' stations by connecting the armature of the meters between the two outside wires of a three-wire system for one period and rate, and between the neutral and one of the outside wires for the other period and rate.

591,201. ELECTRICAL EXCHANGE; A. B. Strowger, F. A. Lundquist and J. and C. J. Erickson, Chicago, Ill. App. filed July 17, 1895. The combination, with a series of wires or contacts of a series of rods or parts, each insulated from the other, and each carrying angularly-displaced contact arms or wipers, means for rotating the rods step by step to bring the arms thereof into engagement with the wires, and a selector for connecting a line-wire with either of said rods.

591,203. COMMUTATOR FOR DYNAMO ELECTRIC MACHINES; J. J. Wood, Fort Wayne, Ind. App. filed April 29, 1897. In a commutator, the combination, with the spider and segments, the latter having substantially parallel clamping portions at opposite ends, of two segmental clamping rings overhanging the opposite clamping ends of the segments, and radial screws or bolts for drawing the segmental clamping rings against the segment ends.

591,225. JUNCTION BOX; J. Cloos, Milwaukee, Wis. App. filed March 6, 1897. The combination, with a junction box, of feeder and main conductors leading thereto and extending therefrom, a bus bar, bars, or conductors with which the feeder or feeders are connected, and switching mechanism for uniting the mains with said bus bar or bars.

591,240. PHASE ADJUSTING-METHOD AND MEANS FOR ALTERNATING-CURRENT APPARATUS; O. B. Shallenberger, Rochester, Pa. App. filed Jan. 9, 1897. The combination, with a field coil supplied with an alternating current, of a second field coil and a transformer having a secondary circuit, including the said second field coil and inductively influenced by two primary circuits connected to the source supplying the said first field coil by circuits having different coefficients of self-induction.

591,241. ELECTRICAL-MEASURING INSTRUMENT; O. B. Shallenberger, Rochester, Pa. App. filed Jan. 26, 1897. In an electrical-measuring instrument, a permanent magnet constituting the field magnet of the instrument, and provided with a pair of polar extensions, each in the form of a ring, said rings being placed side by side, parallel to each other and separated by an air-gap.

591,242. ALTERNATING-CURRENT ELECTRIC MOTOR; O. B. Shallenberger, Rochester, Pa. App. filed June 7, 1888. The method of converting electrical energy of alternating currents into mechanical energy, which consists in establishing by such alternating currents a system of lines of force, causing a portion of such lines of force to produce secondary alternating currents, establishing a second system of lines of force, the general axial line of which is at an angle with reference to that of the first-named system, the time of the phases of such second system being determined by the resuultant of the lines of force inducing the secondary currents and the lines of force due to such secondary currents, and causing the two systems of lines of force to act upon a movable element.

591,251. TROLLEY FINDER FOR ELECTRICAL RAILROADS; P. Goldsmith, Troy, N. Y. App. filed Feb. 10, 1897. In a trolley finder, the combination with two outwardly flaring arms arranged to approach each other,

and the trolley wheel in close proximity to the rim of the latter at its top, and each journaled onto the trolley wheel shaft where projecting beyond the wheel, of a frame part which, at each of its two upper ends, is hinged to the lower end of one of the trolley-finder arms, with the latter and said frame part constructed to lock and to be reversed on their hinged connection with the frame.

591,265. HIGH-TENSION BATTERY; R. Ashley, Port Republic, N. J. App. filed Nov. 27, 1895. A secondary or storage battery, comprising non-conducting cups or trays nested together, but out of contact with each other, forming a vertical stack or pile, the positive and negative electrodes secured to the inner and outer sides of the bottom of said cups, the conductors connected with the negative electrodes of each cup passing up over the edge of the cups and then down to and connected with the positive electrode.

591,267. ALTERNATING-CURRENT GENERATOR; C. S. Bradley, Avon, N. Y. App. filed June 22, 1896. An alternating-current electric generator provided with means for varying the rate of alternation, and adjusting devices to vary the product of capacity and inductance to produce resonance at the several rates.

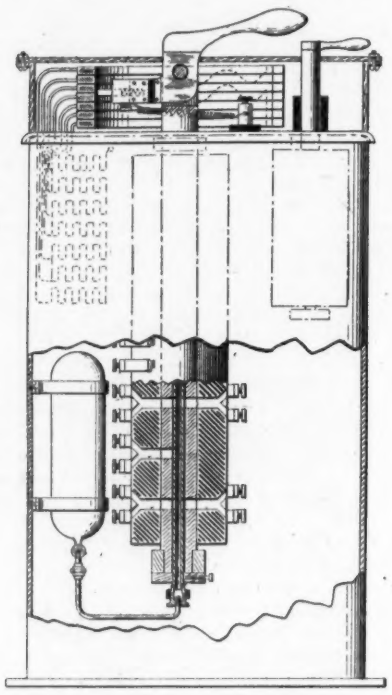
591,268. ALTERNATING-CURRENT MOTOR; C. S. Bradley, Avon, N. Y. App. filed June 22, 1896. An alternating-current induction motor having a revolving element inductively related to a rotary magnetic field and inductively related to an auxiliary stationary circuit, including current-regulating devices.

591,300. OUTLET BOX FOR ELECTRIC WIRING; W. Soons, New York, N. Y. App. filed Dec. 24, 1896. An outlet box for electric wiring, having within the box pillars or lugs for the support of a rosette or other insulating fixture some distance from the bottom of the box.

591,301. ALTERNATING-CURRENT ELECTRIC MOTOR; W. Stanley, Jr., Great Barrington, Mass. App. filed Oct. 23, 1888. An electric motor, consisting of a field magnet having a closed core and having two coils, one adapted to be connected in series with the source of alternating electric currents, and the other acting as a secondary coil with reference to the first, whereby the effects of the current induced in the latter and the current flowing in the former combine to establish poles in the field-magnet core, and an armature in the field of force thus established.

591,314. ELECTRIC-RAILWAY SYSTEM; G. Westinghouse, Jr., Pittsburg, Pa. App. filed Feb. 19, 1894. In an electric railway, sectional working conductors, the sections of which are arranged in laterally disposed pairs, a stationary source of current and means for automatically connecting said stationary source of current with every alternate laterally disposed pair of sections in multiple during the passage of the car.

591,321. LIGHTNING ARRESTER AND CUT-OUT; C. Branzell, Ashland, Wis. App. filed April 1, 1897. In a lightning arrester and cut-out, the combination of the base, the coils mounted thereon and connected in circuit, the plates on the base being connected with one coil and the other



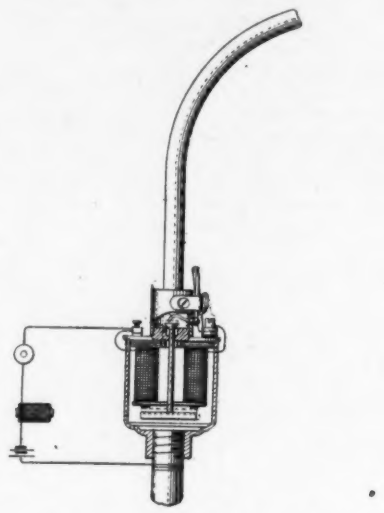
No. 591,100.—Electric Railway.

being connected with the ground, the other coil being connected with the line, a spring connection leading from one of the plates to the instrument terminal, and the lever fulcrumed near its outer end to the base, having an adjustable spring connection leading from its outer end to the base and having its inner end provided with a head or disc for operating on the spring connection to shift it to throw the current into the ground connection.

591,331. ELECTRIC SWITCH; W. A. Drewett, Brooklyn, N. Y. App. filed March 15, 1897. A switch, comprising a base provided with stationary contacts, a contact arm, a spring adapted to hold said arm in its normal open position, a handle, and connections between the handle and arm to move the arm in either direction to close the circuit and to release the arm and permit it to assume its normal position under the influence of the spring to break the circuit.

591,339. RAILWAY TELEGRAPH; A. C. Frieseke, Floral Bluff, Fla. App. filed Nov. 20, 1895. In a telegraph or like system, three conductors, stations connected to said conductors, each containing a two-point switch having its points connected to two of the conductors, receiving and transmitting instruments, wires connecting said instruments to the lever of the switch and the third conductor, and an electric-generating device connected to said third conductor.

591,343. INDIRECT REGULATION OF DYNAMO-ELECTRIC MACHINERY; G. S. Dunn, East Orange, N. J. App. filed July 8, 1896.



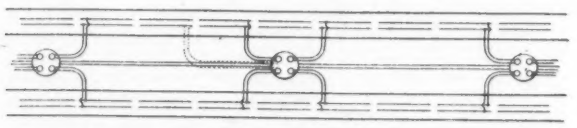
No. 591,076.—Electric Gas Lighting Apparatus.

The combination of a line, a main machine connected to the line, and a regulating machine, with a field coil of the regulating machine connected to the line in series with the armature of the main machine, and with the armature of the regulating machine and a field coil of the main machine, connected across or in multiple with the line and in series with each other, whereby the field strength of the regulating machine is dependent upon the current in the armature of the main machine, and the field strength of the main machine is dependent upon the algebraic sum of the voltages of the line and the regulating machine.

591,344. INDIRECT REGULATION OF DYNAMO-ELECTRIC MACHINERY; G. S. Dunn, East Orange, N. J. App. filed July 10, 1896. The combination of a regulated machine, a main circuit to be supplied with constant current, the armature of the regulated machine being connected in the main circuit, a field circuit for the regulated machine, a regulating machine, the armature of which is connected in this field circuit, a constant-potential source, means dependent upon the constant potential source for exciting the field of the regulated machine, a field coil for the regulating machine, which is connected in the main circuit, the elements being so arranged that the effect of the current from the constant-potential source and the effect of the current in the main circuit oppose each other in the field circuit of the regulated machine so that its field is a resultant due to the difference between their effects, and varies with changes in the strength of the current in the main circuit.

591,345. INDIRECT REGULATION OF DYNAMO-ELECTRIC MACHINERY; G. S. Dunn, East Orange, N. J. App. filed June 22, 1897. The method of regulating electric motors which consists in supplying the armature with a constant current, supplying the field from a source of energy separate from that which supplies the armature, and varying the field by varying the effective E. M. F. in the field circuit simultaneously with the speed of the armature of the machine to be regulated.

591,365. MAGNETO-ELECTRIC GENERATOR; J. A. Williams, Cleveland, Ohio. App. filed May 3, 1897. In a magneto-electric generator, the pole piece consisting of a plate cut, stamped and formed with the lower edge



No. 591,314.—Electric Railway System.

slitted, folded upward, and with the outward bends forming seats for the permanent magnets.

591,369. ILLUMINATED ELECTRIC SIGN; G. K. Burleigh, Northfield, N. H. App. filed Oct. 31, 1896. In an electric sign, a main circuit, a plurality of branch-lamp circuits, circuit closers intermediate the main and branch circuits, a spring motor to operate the circuit closers, and a cut-out, one member of which is connected with the main circuit and the other member with the circuit closers, a yoke-like movable member of said cut-out being engaged and moved by the expansion of the motor spring, to finally cut out the lamps.